Emotion-sensitive Human-Computer Interaction (HCI): State of the art - Seminar paper *

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ABSTRACT

Emotion-sensitive Human-Computer Interaction (HCI) is a hot topic. HCI is the study, planning and design of the interaction between users an computer systems. Indeed today a lot of research is moving towards this direction. To attract users, more and more developers add the emotional side to their applications. To simplify the HCI, systems must be more natural, efficacious, persuasive and trustworthy. And to do that, system must be able to sense and response appropriately to the user's emotional states. This paper presents a short overview of the existing emotion-sensitive HCI applications. This paper focused on what is done today and brings out what are the most important features to take into account for emotion-sensitive HCI. The most important finding is that applications can help people to feel better with technologies used in the daily life.

General Terms

Emotion in HCI

Keywords

Emotion HCI, Affective HCI, Affective technology, Affective systems

1. INTRODUCTION

First affective-applications must collect emmotional's data with facial recognition, voice analysis and detecting physiological signals. Then the system interpret collected data and must be adapting to the user

In the past, the study of usability and emotions were separated but for some time, the area of human-computer interaction has evolved and today emotions take more space in our life and the affective computing appeared. Affective computing is a popular and innovative research area mainly in artificial intelligence. Affective computing consist of recognition, expression, modeling, communicating and responding to emotions [4]. Research in this domain contributes to many different domains such as aircraft, jobs in scientific sectors like lawyers or police, anthropology, neurology, psychiatry or in behavioral science, but for this paper we will focus especially on HCI. In this paper we will approach different elements of Emotion-sensitive HCI. Firstly we briefly discuss the role of emotions and how they can be detected. Then, we explain the research areas related to affective computing. Finally we make a state of the art survey of existing affective application.

*Seminar emotion recognition : http://diuf.unifr.ch/main/diva/teaching/seminars/emotion-recognition

2. ROLE OF EMOTIONS

Emotions are an important factor of life and they play an essential role to understand user's behavior with computer interaction [1]. In addition, the emotional intelligence plays a major role to measure aspects of success in life [2]. Recent researches in human-computer interaction don't focus only on the cognitive approach, but on the emotions part too. Both approaches are very important, indeed take into acount that emotions of the user solve some important aspects of the design in HCI systems. Additionnaly the human-machine interaction could be better if the machine can adapt its behavior according to users; and this system is seen more natural, efficacious, persuasive, and trustworthy by users [2]. The following question is asked "Which is the connection between emotions and design?" and the respond is that "Our feelings strongly influence our perceptions and often frame how we think or how we refer to our experiences at a later date", emotion is the differentiator in our experience [1]. In our society, positive and negative emotions influence the consumption of product and to understand the decisional process, it could be crucial to measure the emotional expression [1]. Emotions are an important part in our life, it's why affective computing was developed. As say in [3] "affective computing is to develop computer-based system that recognize and express emotions in the same way humans do".

In human-computer interaction, the nonverbal communication plays an important role, in that we can identify the difficulties that users stumble upon, by measuring the emotions in facial expressions [1]. Therefore in [3] we talk about a number of studies that have investigated people's reactions and responses to computers that have been designed to be more human-like. And several studies have reported a positive impact of computers that were designed to flatter

and praise users when they did something right. With these system, users have a better opinion of themselves [3].

By cons, we have to be careful because sometimes, the same expression of an emotion can have a different signification in different countries and cultures. A smile in Europe is the sign of happiness, pleasure or irony. But for japanese people, it could simply imply their agreement with the applied punishment or could be the sign of indignation associated with the person applying the punishment [1]. These ethnic differences should make us aware of different results with the use of the same affective system in different countries.

3. EMOTIONAL CUES

To understand how emotions affect people's behavior we must understand the relationship between the different cues such as facial expressions, body language, gestures, tone of voice, etc. [3]. Before creating an affective system, we must examine how people express emotions and how we perceive other people's feelings.

To have an intelligent HCI system that responds appropriately to the user's affective feedback, the first step is that the system must be able to detect and interpret the user's emotional states automatically [2]. The visual channel (e.g., facial expression) and the auditory (e.g. vocal caps) like vocal reactions are the most important features in the human recognition of affective feedback. But other elements need to be taken into account, for example body movements and the physiological reactions. When a person judge the emotional state of someone else, it relies mainly on his facial and vocal expressions. However some emotions are harder to differentiate than others and need to consider other types of signals such as gestures, posture or physiological signals.
A lot of research have been done in the field of face and gesture recognition, especially to recognize facial expressions. Facial expressions can be seen as communicative signals or can be considered as being expression of emotions [6]. And they can be associated with basic emotions like happiness, surprise, fear, anger, disgust or sadness [1].
Another tool to detect emotions is the emotional speech recognition. In the voice several factors can vary depending on emotions, such as pitch, loudness, voice quality and rhythm.
In case of human-computer interaction, we can detect emotions by monitoring the nervous system because for some feelings, physiological signs are very marked [1]. We can measure the blood pressure, the skin conductivity, the rate of breathing or the finger temperature. Changing in physiological signals means a change in the user's behavior. Unfortunately, physiological signals play a secondary role in human recognition of affective states, these signals are neglected because to detect somenone's clamminess or heart rate, we should be in a physical contact with the person. The analysis of the tactile channel is harder because, the person must be wired to collect data and it's usually perceived as being uncomfortable and unpleasant [2]. Several techniques are available to capture this physiological signs; Electomyogram (EMG) for evaluating and recording the electrical activity produced by muscles, Electrocardiogram to measure the activity of the heart with electrodes attached to the skin or skin conductance sensors can be used [6] .

All these methods to collect data are very useful but they they do not seem always easy to use. Firstly, available technologies are restrictive and some parameters must absolutely be taken into account to have valid data. We must differentiate users by gender, age, socio-geographical origin, physical condition or pathology. Moreover we need to remove the noise of collected data like unwanted noise, image against the light or physical characteristics such as beard, glasses, hat, etc. Secondly, to collect physiological signals, we must use some intrusive methods like electrodes, chest trap or wearable computer [6].

4. EMOTION-SENSITIVE APPLICATION

4.1 Research areas

The automatic recognition of human affective states can be used in many domains besides the HCI. In fact the assessment of different emotions like annoyance, inattention or stress can be highly valuable in some situations. The affective-sensitive monitoring done by a computer could provide prompts for better performance. Especially for certain jobs like aircraft and air traffic controller, nuclear power plant surveillance or all jobwhere we drive a vehicle. In these professions attention to a crucial task is essential. In scientific sectors like lawyers, police or security agents, monitoring and interpreting affective behavioral signs can be very useful. These information could help in critical situations such as to know the veracity of testimonies. Another area where the computer analysis of human emotion can be benefit is the automatic affect-based indexing of digital visual material. Detection of pain, rage and fear in scenes could provide a good tool for violent-content-based indexing of movies, video material and digital libraries. Finally machine analysis of human affective states would also facilitate research in anthropology, neurology, psychiatry or in behavioral science. In these domains sensitivity, reliability and precision are recurring problems, this kind of emotion recognition can help them to advance in their research [2].

In this paper we focused on HCI and one of the most important goal of HCI's application is to design technologies that can help people feeling better. For example how an affective system can calm a crying child or prevent strong feeling of loneliness and negative emotions [3].

A domain where recognition of emotions in HCI is widely used is the evaluation of interface. The design of an interface can influence strongly the emotional impact of the system on the users [3]. The appareance of an interface such as combination of shapes, fonts, colors, balance, white space and graphical elements determine the first user's feeling. Moreover there can have a positive or a negative effect on people's perception of the system's usability. For example with good-looking interfaces users are more tolerant because the system is more satisfying and pleasant to use. For example if the waiting time to download a website is long, with a good-looking interface, the user is prepared to wait a few more seconds. On the contrary, computer interfaces can cause to user frustration and negative reactions like anger or disgust. It happens when something is too complex, if the system crashes or doesn't work properly, or if the appareance of the interface is not adapted. Therefore the recognition of emotions is important to evaluate the usability and the interface

of applications. Emotions felt by user play an important role in the success of a new application.

Another big research area is the creation of intelligent robots and avatars that behave like humans [3]. The goal of this domain is to develop computer-based systems that recognize and express emotions like humans. There are two major sectors, affective interface for children like dolls and animated pets or intelligent robots developed to interact and help people.
Safety driving or soldier training are other examples of emotionnal research areas. Sensing devices can be used to measure different physiological signals to detect stress or frustration. For drivers, panic and sleepiness levels can be measured and if these signals are too high, the system alerts the user to be more careful or advise to stop for a break. The physiological data from soldiers can be used to design a better training plan without frustration, confusion or panic [6]. Finally, sensing devices can also be used to measure the body signals of patients that are having tele-home health care. Collected data can be sent to a doctor or a nurse for further decisions [6], [5] .

4.2 Applications

In this section, we make a state of the art of different types of existing affective-applications.

4.2.1 Emoticons and companion

The evolution of emotions in technology is explain in this book [3]. The first expressive interfaces were designed by emoticons, sounds, icons and virtual agents. For example in the 1980's and 1990's when an Apple's computer was booted, the user saw the happy Mac icon on the screen. The meaning of this smiling icon was that the computer was working correctly. Moreover, the smile is a sign of friendliness and may encourage the user to feel good and smile back.

An existing technique to help users is the use of friendly agents at the interface. This companion helps users to feel better and encourages them to try things out. An example is the infamous Clippy, the paper clip with human-like qualities as part of their windows 98 operating system. Clippy appears in the user's screen when the system thinks that the user need some help to make some tasks [3].

Later, users have also found ways to express emotions through the computer by using emoticons. The combination of keyboard symbols that simulate facial expressions, allows users to express their feelings and emotions [3].

4.2.2 Online chat with animated text

Researches demonstrated that animated text was effective to convey a speaker's tone of voice, affection and emotion. Therefore an affective chat system uses animated text associated with emotional information is proposed in [9]. This chat application focuses only on text messages because it's simpler than video, the size of data is smaller and concerns less the privacy. A GSR (Galvanic Skin Response) sensor was attached to the middle and to the index fingers of the user's non-dominant hand to collected necessary affective information. An animated text is created according to these data. With this method, the peaks and troughs of GSR data are analyze to detect emotions in real-time and applies it to the online chat interface. Because it's difficult to obtain valence information from physiological sensors, the user specifies manually the animation tag for the type of emotion, whereas physiological data are used to detect the intensity of emotion. Twenty types of animations are available to change the speed, size, color and interaction of the text. The user specifies the emotion with a tag before the message. Through this animated chat, the user can determine the affective state of his partner.

4.2.3 Interactive Control of Music

We discover an interface to mix pieces of music by moving their body in different emotional styles [8]. In this application, the user's body is a part of the interface. The system analyzes the body motions and produces a mix of music to represent expressed emotions in real time. To classify body motions into emotions, the machine learning is used. This approach give very satisfactory results. To begin, a training phase is needed, during which the system observes the user moving in response to particular emotional music pieces. After the training part, the system is able to recognize user's natural movements associated with each emotion. This phase is necessary because each participant has a very different way to express his emotions and body motions are very high-dimensional. There are variations even if the same user makes several times the same movement. A database of film music classified by emotions is used. The user's detected emotion are mapped with corresponding music in database and a music mix is produced.

4.2.4 Tele-home health care

Interesting affective applications are developed in the health care, for example an Tele-home health care (Tele-HHC) application discovered in [5]. The goal of this system is to provide communication between patient and medical professionnal via multimedia and empathetic avatars when hands-on care is not required. The Tele-HHC can be used to collect different vital sign data remotely. This system is used to verify compliance with medicine regimes, to improve diet compliance or to assess mental or emotional status. Knowing the patient's emotional state can significantly improve his care. The system monitors and responds to patients. An algorithm map the physiological data collected with emotions. After that, the system synthesizes all informations for use by the medical staff. For this research a system which observe the user via multi-sensory devices is used. A wireless non-invasive wearable computer is employed to collect all needed physiological signals and mapping these to emotional states. A library of avatars is built, and these avatars can be used in three different ways. Firstly, avatars can assist the user to understand his emotional state. Secondly they can be used to mirror the user's emotions to confirm it. Finally they can animate a chat session showing empathic expressions.

4.2.5 Arthur and D.W Aardvarks:

Systems related to children is common research area. Positive emotions play an important role in learning and mental growth of children. Therefore an affective interface can be important in achieving the learning goals. Two animated, interactive plush dolls ActiMates Arthur and D.W were developed [10]. These two characters are creations of children's

Figure 1: ActiMates D.W and ActiMates Arthur

author Marc Brown, and are familiar to children for more than 15 years. These dolls look like animals but have a human behavior with their own personalities. They can move and speak. Seven sensors located in their body allows children to interact with them. Each sensor's has one defined function. When the dolls speak three emotional interactions are used: humour, praise and affection. Arthur and D.W. can ask questions, offer opinions, share jokes and give compliments to children. Children interact with these dolls to play games or to listen joke and secret. The goal of these dolls is to promote the mental growth of children through the systematic use of social responses to positive affect during their playful learning efforts.

4.2.6 Affective diary

An affective diary to express innerthoughts and collect experiences or memories was developed [7]. This diary captures the physical aspects of experiences and emotions. The most important element that differs from other traditional diaries is the addition of data collected by sensors like pulse, skin conductivity, pedometer, body movement and posture, etc. Collected data are uploaded via a mobile phone and used to express emotions. Other materials from the mobile phone like texts, MMS messages, photographs, videos, sounds, etc. can be combined and added to events or memories to create the diary. With this system, a graphical representation of the emotions of the day can be created. For that, the user must load all data into the computer, then a movie with ambiguous, abstract colourful body shap is created. This film is consolidated by an expressive sound or music played in background. The user can modify and organize "the movie", edit the content, change the body state or the color, add text, etc.

5. CONCLUSION

We addressed the role of emotions in life and HCI. We have highlighted the fact that emotions are an important part of the human-computer interaction. The different features available to automatically detect emotions of users are the visual, the auditory and the physiological channels. By combining all these data the affective system must be able to determine the emotion of the current user. Several research areas like aircraft, scientific sectors or HCI used the emotions recognition. This subject is hot and attractive but relatively new. Not real applications are already commercialize, currently there are only prototypes of affective application.

This is a topic that has a future and will be increasingly present in our technologies life because emotions play an important role in our life. Affective interfaces and applications can help people to feel better with computers and in the daily life. Stress, frustation and angry can be reduced with sensible and adaptive systems.

Finally the challenge today is to improve technologies to collect data from different features. Existing systems must be improve to really identify emotions despite factors that can skew results. Tools to automatically recognize emotional cues must keep only key items and must throw all the noises.

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