

Implications of emotions in human computer interaction and affective computing

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ABSTRACT

The most basic component of being human is having emotions which add richness to everything that we experience in this life. The design, implementation and evaluation of interactive computer systems are incomplete without the understanding of human emotions. Moreover, emotional intelligence is the way forward as adapting to user needs is very critical for success. HCI systems need to be natural and trustworthy for which emotional side of human nature needs to be incorporated in computers. The paper will present an overview of existing HCI applications that utilize emotions and focus on its effects in normal daily life.

Keywords: human computer interaction; emotions; interactive computer systems; implications; HCI;

1. INTRODUCTION

We have been observing an unprecedented growth in technologies incorporating human computer interaction (HCI). With the ongoing technological advancement in almost all areas of life the requirement for effective and desirable interaction between machines and humans is being redefined and is more important than ever before. Emotions are integral part of all the human activities including our interaction with the computers. The community related and working with HCI devices has been showing a significant keenness to add emotions and affective computing in their work. There has been a particular focus on emotion recognition as it will definitely help and improve the ways computers interact with humans.

Not all computers need to understand or read emotions. They can do their tasks efficiently without them thus, it is ok to keep them like that. But there certainly are areas where the interaction between computers and humans can be improved if the computer can adapt to their specific users based on the emotions.

Emotional communication along with specific information can really expand the horizon of HCI. This is where a combination of psychology, computer science and cognitive science comes into play as the field of affective computing. The need of the hour is to make the machines interpret our emotions and make intelligent decisions based on them. People in many domains have been working on these issues but for this paper we will focus on HCI related fields. In the next section, we will start with emotions, their detection and involvement in existing applications.

2. UNDERSTANDING EMOTIONS

The most fundamental thing about humans is their emotions including but not limited to joy, hate and anger. These are all small experiences that bring us pleasure or displeasure and are often very closely related to personality, temperament and mood. Emotions are complex and involve both cognitive and physical events. Physiologically it's how the nervous system acts to different stimuli. External things affect our body biologically and that is interpreted as one of the emotion. We feel a lot of emotions daily and based on these emotions we make our decisions and that are what we want an HCI application to emulate.

There have been a lot of different definitions of emotion but all can agree on two things. First that emotion is a reaction to event that is deemed relevant to needs and concerns of different individuals. Secondly, emotions completely cover the behavioral, cognitive, affective and physiological aspects [1]. Based on LeDoux's work in neuropsychology as shown in Figure 1 the thalamus, limbic system and cortex makes up this model. Interaction exists between cortical brain region and limbic system. Because of this interaction there is a huge flow of complex sensory information that allows processing in the cortex which ultimately affects the limbic system. In the same way, any process in the limbic system can initiate high level cognitive functions. Cortex has very strong influence on all the actions and mechanisms governing autonomic and emotional responses. To summarize all external reactions are received by thalamus which after doing the basic signal analysis sends them to cortex for high level analysis as well as to limbic system for any appropriate body response.

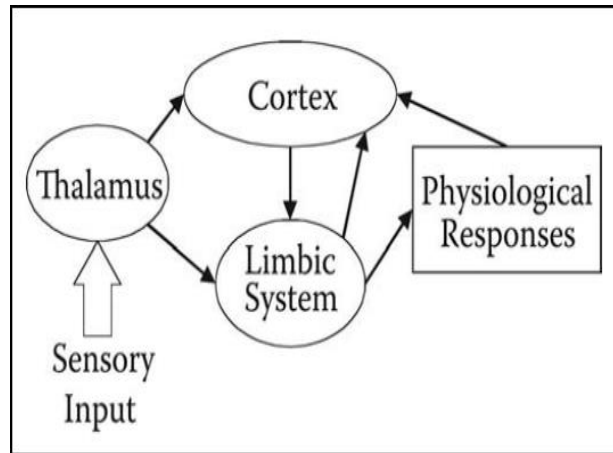


Figure. 1 Neurological structure of emotion

3. HUMANS AND COMPUTERS

In the subject, interaction the output of one entity is the input of the second entity and vice versa. For example, human emotions in response to any event will be considered as an input by the computer. Humans take input from the use of senses and output the results through their effectors and their motor control [2]. We can consider vision hearing and touch as the primary sensors which output through voice, eyes and body position. For computers interaction is the process of information transfer. They have various input and output devices that ultimately make up a computer which is able to make decision in the matter of milliseconds.

This interaction between humans and computers usually take place through an interface which is a very important part of this interaction. These interfaces can be of various types ranging from speech recognition, visual recognition to the state of the art graphical user interface of today. Research in HCI has focused a lot on improving the quality of interface as well as the interaction. A great amount of focus is placed on making the interfaces active in contrast to the passive interfaces that are prevailing in current times. The importance of having a good interface can be highlighted by the problems that a bad interface creates. Everyone can relate to the “Three mile Island accident” where the final report suggests that a bad human computer interface was at least partially responsible for the nuclear meltdown accident. A lot of accidents in aviation industry have also been attributed to bad interaction between the human and computers. Thus, a plan made by a human is executed by a computer and results are evaluated. This can be summarized by following points

- The purpose of the interaction is established
- Intention of the interaction is formulated which is more specific than the purpose
- Based on the intention how the action is to be carried out
- Perceiving the state of the system
- Interpreting the state of the system
- Evaluation of the state of the system in line with our goals and intentions

Communication is in task language on the user side and in core language on the systems side. Users desired task need to be provided as an input. Task is phrased highlighting the important features and need to be mapped nicely as the input language as it will make the process easy and simple.

The response of the above-mentioned input is translated to the system stimuli. System goes through a state transition completing the execution phase. After this the evaluation phase starts which gives an output after analyzing the system stimuli which is subsequently translated into the stimuli of the user. Basically, the responses of the input are translated into system language where the evaluation and execution takes place to give us results to the stimuli of the user.

4. IMPORTANCE OF EMOTIONAL CUES IN HCI

Humans generally are expressing their emotions in real life and to machines as well but machines cannot recognize them without external help. This can lead to user frustration and that is why we need to enable machines to recognize different signs in our emotions. Different emotional cues like gestures, voice level, body language, facial expressions affect human behavior and we need to understand the relationship between them. Before creating a human computer interactive device, it is pertinent that we must understand how we perceive and express emotions. Visual and auditory channels will be the most focused as they are the most important in human recognition of affective feedback [3]. But we cannot limit ourselves to this, as other emotional cues are also significant in decision-making. A good example of such emotions would be body gestures. Speech is equally important as its various features such as loudness, pitch and rhythm may be indicating towards different behaviors altogether.

In HCI, we can detect different emotions from the nervous system as different feelings have different physiological responses that can be monitored [4]. We can measure temperature, blood pressure, skin conductivity and any change in them can directly relate to a change in human behavior. But the problem is to measure a thing like heart rate one must be in physical contact with the person. There are methods like ECG & EMG but none of them are easy to use. Thus, the first major challenge, that HCI devices face, is to overcome technological restrictions through measurement of some parameters which would be necessary for valid analysis. Table 1 describes the different emotions and their cues.

Table. 1 Emotions and their cues

Emotion	Emotional Cues
Fear	Brows raised Wrinkles on forehead drawn together Raised upper eyelids and drawn lower eyelid Open mouth Jaws dropped Lips are tensed/stretched
Disgust	Wrinkled nose Upper lip is raised Lower lip is raised or lowered Raised cheeks Pushed up lids with lined beneath it Lowered brows
Surprise	Curved and high brows Skin below brow stretched Wrinkles on forehead Eyelids opened wide Jaw drop without any tension
Anger	Brows lowered and drawn together Vertical lines between brows Lower lid is tensed, may or may not be raised Upper lid is tensed Eyes with hard appearance Firmly pressed lips Dilated Nostrils
Sadness	Eyebrows drawn up Skin below eyebrow is triangulated Trembling Lips Raised upper lid inner corner
Happiness	Mouth may be parted Blushing cheeks Wrinkle from nose to lip corner Lips drawn back and up Crow's feet wrinkle going to outer corner of eyes

In vocal communication, emotional arousal is most easily distinguished. By using speech, we can also relate to a lot of other emotions through different properties of acoustics such as rhythm, pitch and amplitude. A user who is sad

or bored will be speaking in a significantly lower pitch voice whereas a person who is happy or angry will speak faster, louder and with very high energy. Murray & Arnott gave a detail account of acoustics and how they are related with several human emotions. Summary is given in Table 2.

Table.2 Voice and emotions

	Speech Rate	Pitch Average	Intensity
Fear	Much Faster	Very much Higher	Normal
Anger	Slightly Faster	Very much Higher	Higher
Sadness	Slightly Slower	Slightly Lower	Lower
Happiness	Faster or Slower	Much Higher	Higher
Disgust	Very much Slower	Very much Lower	Lower
	Voice Quality	Pitch Changes	Articulation
Fear	Irregular voicing	Normal	Precise
Anger	Breathy chest tone	Abrupt on stressed syllables	Tense
Sadness	Resonant	Downward Inflections	Slurring
Happiness	Breathy Blaring	Smooth upward Inflections	Normal
Disgust	Grumbled Chest Tone	Wide downward terminal inflections	Normal

5. AFFECT RECOGNITION BY USERS

When it comes to affect recognition, both user and computers play a pivotal role. When a user uses an interface it constantly monitors the state of its partner i.e. the computer. To create an efficient system the need is not only to detect the emotions but also to express them as well. The most common ways of expression are believed to be gesture and facial expression. We can use animations in computer to exhibit emotions but they are not as intricate as human emotions. One thing that we can do is to use bit exaggerated emotions with animated characters but it has a downside. The exaggeration can sometimes lead to false assumptions which may not be acceptable in certain fields and scenarios.

We can also use characters that can talk. Recorded messages can be used but are highly inflexible and rigid. Work is being done on applications using text to speech with focus on exhibiting the correct emotion. Moreover, we can express the affective state using explicit words and statements like “I am angry”. However, a difference in non-verbal and verbal communication can lead to a feeling of distrust because of the character’s affective state being masked.

6. EMOTION SENSITIVE RESEARCH AND APPLICATIONS

The research related to emotions has great benefits in a lot of domains other than HCI. Emotions like stress and annoyance can be highly valuable in situations where top notch performance is required at all times. Jobs like nuclear power plant maintenance, driving a public vehicle where attention is of the most importance comes to mind. There have been several incidents which could have been avoided if there was a better interaction between machines and humans. Similarly interpreting behavioral signs can be of great importance to lawyers, Police and security agencies in determining the authenticity of someone.

Since we are focusing on HCI in this paper and one of the major objectives of HCI devices is to make people feel better. For this the interface needs to be very strong. A good-looking interface will make people tolerant and will also be very pleasant to use. On the contrary, complex GUIs and computer interfaces can be a cause of frustration that can

lead to negative emotions like anger [5]. Affective computing can help us in such situations by identification of situations causing frustration and moreover devising strategy to improve the interaction. Thus, the bottom line is that the success of application depends a lot on how the interface affects the users emotionally.

With the passage of time scientists and researchers have tried to make the computer more intelligent so that it can help people to become more intelligent. However, the role of emotions has been neglected to some extent and need serious attention. Now the focus is shifting and research is being done in several areas that highlight and incorporate emotions in technological applications.

a) Affective learning partner

A lot of research is going on in creating a tool that can understand variety of social emotional skill and it help the users in meeting their needs of learning something new. The system will be making decisions based on non-verbal emotional cues using different sensors that will be monitoring things like posture, mouse movement, video, facial impressions etc. Understanding when the person does not understand or feeling confused and explaining that particular thing in greater detail may revolutionize the education department.

b) Emoticons and application partners

Emotions in technology evolved with the introduction of emoticons and helping partners. If you can remember the MAC booted with a happy face sign adding friendliness and emotions to its startup. Similarly, Clippy turned out to be a sensation in the office suite that helped with routine user task. Nowadays, emotions are being expressed in every technological form of communication through the use of smileys. A combination of keyboard symbols that stimulate facial expressions can realistically transfer feelings and emotions. Sometimes it is hard to tell what a person is feeling from a line of text. Emoticons can help us in the situations. They are visual representation of faces in different emotions like sadness, happiness and anger etc.

c) Virtual health partner

Health care has a lot of potential in affective applications. A lot of health care applications can be made to aid the patients. One of them is to provide medical assistance to the patient remotely. We can establish a communication between the patient and the medical specialist through a multimedia channel where hands on treatment is not required. This can be very effective in remote areas of third world countries where medical facilities are rather scarce. This can also be used to take expert opinion from high qualified doctors who may not available in your country. The system can collect data remotely and also monitor the patient. If the system can identify the emotions as well that could work wonders. It can help the patient with much better care.

d) Emotions in Speech

Since speech is being chosen as the main way of interface between humans and computers these days, it is imperative to recognize emotions in spoken sentences and commands. This will help to build interfaces that are more adaptive and responsive to user behavior. The need of the hour is not only to know what is said but how it is said because it will ultimately affect the decision-making process. Given this importance, all human machine interfaces should be able to accommodate the human emotions appropriately.

Using the acoustic and speech properties like pitch, timing, quality, and articulation, several applications can be built in our daily routine usage. These can help us to simplify as well as prioritize requests based on the emotions that are calculated through speech. For example, an automatic dialog system which has the ability to detect emotions can respond to callers based on their emotional state or can even pass the call to human operators. This is basically a system that categorizes emotional states. This will require techniques not only from signal processing but will also include linguistic and physiological analysis of emotions.

7. FUTURE AVENUES

There are a lot of open questions that must be addressed for advancement in affective recognition which ultimately tells us about the future areas of research in emotions and HCI.

First of all, there is a need to prioritize emotions so it can be decided which emotions must be addressed by the interface on priority. The difficult task here would be to categorize those emotions which depict different behavior

across different cultures. Some emotion detection can be really simple to implement but their manipulation and how they are treated with different cultures and individuals may result in further opportunities/problems.

The second thing is how accurate should an emotion detecting interface be. Humans are not the best judge of emotion but they however are still better than computers of our age. We need to determine a threshold as even humans cannot determine emotions accurately all the time. We know very little about the level of confidence required to effectively interpret a person's emotional state.

When two people meet it is obvious with no doubt that they are observing or rather monitoring each other's emotional state and are interacting based on their evaluation of it. But when it comes to machines an explicit permission would be required before doing anything. Another possible avenue for future work is the area of persuasive computing. The basic idea is that people respond in the same way when they are taken care of, whether it is by a person or a computer. Caring agents have a better effect in motivating clients because of:

- People usually trust information that is delivered by a source which they trust
- Caring is a reciprocal gesture. People usually are more lenient and willing to comply with humans or computers that care about them

But we must also be aware of the dis-advantages as such a relationship can easily be exploited. For example, such an interaction may coerce a user to spend money where he might be at a loss or which might not be beneficial or necessary. On the other hand, it can help people to do exercise and adopt a healthy living style with good eating habits. It can also motivate students to focus more on their studies, work harder and learn more. This ability to impact the decision can be a very fruitful and potentially very huge area for future research and investigations.

8. CONCLUSION

The role of emotion in HCI was discussed in great depth and the fact was highlighted that emotions are an integral part of HCI. They can improve the interaction as well as introduce new application areas. There are a lot of features available for emotion detection that include but are not limited to audio and visual physiological channels. Using them the emotions can be determined by affective applications with quite certainty. Emotions in HCI as well as many other domains are being used. There is a great promise in terms of new applications in this field of research. With the technological advancement going on in current times it is inevitable as well. Affective applications and interfaces will be the key to make lives easier and happy. The upcoming challenge would be to collect data in the most accurate and easy ways with prioritization of some emotions over the others.

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