Analysing Human Feelings by Affective Computing - Survey

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Abstract—**Affective computing is one of the active research topic getting a lot of research attention recently. This increase in research interest is driven by many areas that are being worked on such as machine-based fact finding, smart over-seeing, perceptual connection, and so on. Identifying or deducing the feelings while they are on a particular task has a multidisciplinary domain involvement. This paper mainly emphasizes on basics of computing feelings while they are in session.**

Keywords— Affective Computing; emotions; human emotions; applications

I. INTRODUCTION

Computers are playing a very important and at times necessary part in our daily living. Although computers already are involved in lot of tasks of generating answers by use of logic and deduction, wherein they can say very well predict events in the near future like the state of weather, can manage complex systems like nuclear plants, but we still do not take into account the state they are in as "living". Computers are said to be very different from we humans from the perspective of "feelings". These feelings have a stigma in science; they are hard to believe and are at times labelled as inherently non-scientific. Scientific principles are formed based on reasoning thought, logical deductions, reasoning arguments, testable starting and ending states, and repeatable experiments. But feelings are a strange thing, which get in the way of, and the pleasure of discovery that leads the development of science. In fact, many scientific observations have been caused out of fear.

There is no agreement that cannot be taken as having authority. If it is has been seen before, it is scientific! So is feeling. As for the person, feeling is a special form of having thoughts; its Target is special outlines not always in agreement like "Value". As the underlying values become different, our feelings change. There is no great point or amount unlike between other science like mathematics or physics. So to go over the limit of computers, the idea of "Affective Computing" is introduced by R.W. Picard in 1995 [1].

It is to be noted that "Affective Computing" doesn't mingle with the quality of computers emotions. It would be imperative to first begin with human emotions, to get a basic grasp on them and thus to outline the relation with computers. Then based on human like emotions, the computers state of being will be put into use under the idea of affective computing and its different points of view.

II. AFFECTIVE COMPUTING

2.1 How emotions are related to Affective Computing?

Affective computing is the process to learn, observe and develop systems and applications that can sense, interpret, procedure, and pretend human like affects. It is a field of work spanning computer science, psychology, and cognitive science. While the origins of the topic may be traced as far back in history as with humans early philosophical reasoning into emotion, the more quantifiable recent work based on computer science got shape with the bath breaking study of R. W. Picard's 1995 paper on affective computing [1].

A guiding reason for this observation is the power to simulate empathy. The machine should take as having certain because of the strong feeling state of humans and adjust the computers behaviour towards humane user's, thus giving a correct direction for the user's emotions.

2.2 Which are the emotions that can be identified?

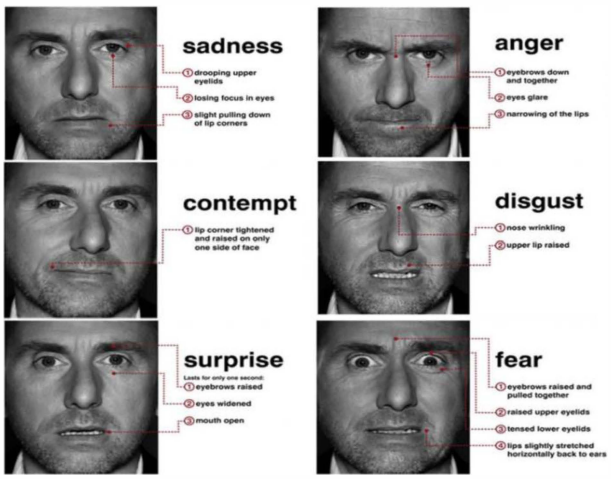

Fig. 1 Basic Emotions

The six basic human emotions are Fear, Anger, Happiness, Surprise, Disgust and Sadness. According to FACS – Facial Action Coding System[2]by Paul Ekman[3] which can be identified by observing the attributes of human face as illustrated in figure 1.

2.3 Areas of Affective Computing

- Detecting and recognizing emotional information

Sensing strong feelings begins with information gathering from action less sensors which take in facts about the user's physical state or behaviour. The facts gathered are of the form of human Cues used to perceive feelings. For example, a camera might take pictures of the human face; identify body position thus revealing human feeling, while a microphone may convert human sound to electric signals based on spoken words. Many other specific sensors can be sued to discover particular feelings by directly measuring physiological facts, such as the human's skin temperature etc. as depicted in figure 2.

This captured information is processed to extract purposeful information from the gathered facts. This is completed using machine learning methods that process unalike modalities, such as use of words, natural language processing, or of the face words discovery, and produce either tickets giving name-value pairs (joined to clothing) (i.e. 'mixed up') or orders in a valence-arousal space.

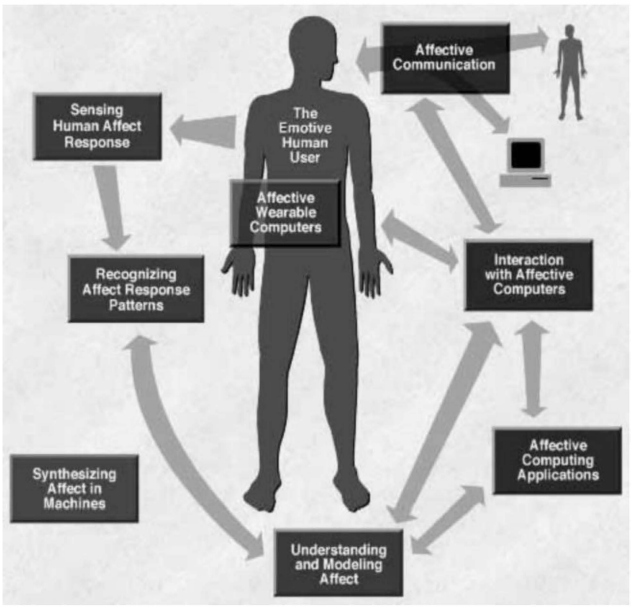

Fig. 2 Research Areas in Affective Computing

- Emotions in machines

Another area within feelings computing is the design of computational systems to exhibit either innate strong feelings powers or that is able of as certainly acting the part of feelings. A more useful move involving computers is based on current technology based powers, is the simulation of feelings in taking pleasure in communicating agents to improve interactivity between human like and machine like communications. While human like feelings are often connected with strong waves in hormones and other neuropeptides, feelings in machines might be connected with outline states connected with forward development (or exist without of forward development) in self-ruled learning systems. In this perspective, feelings are strong states which are time derivatives (perturbations) in the learning curve of a computer based learning system based on rules [4].

2.4 Potential Applications

Consider e-learning applications based on computers wherein computing the users feelings can be used to adjust the presentation, content can be more polished and tasteful form may be used while teaching when a learner is uninterested, or paused. Psychological being healthy, services like recommendations, usage suggestions, can help the user based on current feelings by computing applications when working out a particular user's state of feelings [5].

Robotic systems capable of giving out affective data exhibit greater flexibility while one works in uncertain or complex environments. Buddy gadgets, like digital pets, use affective computing abilities to enhance realism and provide a higher degree of autonomy [6].

Other probable applications are arranged on social monitoring. For example, a car can monitor the emotion of all occupiers and engage in other safety measures, such as informing other vehicles if it detects the driver to be irritated. Affective computing has possible applications inhuman computer interaction, such as affective mirrors allowing the operator to see how he or she performs; emotion monitoring managers sending a warning before one sends an irritated email; or even music players selecting tracks centred on mood [7].

An idea, put forth by Romanian researcher Dr.NicuSebe in an interview, [8] is the analysis of a person's face while they are using a certain product (he stated ice cream as an case).Businesses would then be able to use such analysis to infer whether their product may or may not be well established by the respective market.

One could also use affective state recognition in order to judge the impact of a TV commercial on viewers through a real-time audio-visual recording of that being and through the subsequent study of his or her facial look. By averaging the outcomes obtained on a large collection of subjects, it would be wise to deduce whether that particular commercial (or movie) had the desired effect and what are the elements which interest the viewer most [9].

Affective computing is also being applied to the growth of communicative technologies for use by people with Autism [10].

2.5Affective Haptics

Affective haptics is a relatively new and developing area of research which emphases on the study and plan of devices and systems that can provoke, improve, or influence the emotional state of a human by means of sense of touch. The research area is highlighted in the paper by Dzmitry Tsetserukou et. al. [11] Driven by the motivation to enhance social interaction and expressively immersive experience of users of real-time messaging, virtual, augmented realities, the idea of reinforcing (intensifying) own moods and reproducing (simulating) the emotions felt by the communicating partner was planned.

Four simple haptic (tactile) channels leading our emotions can be illustrated, [11]
(1) Physiological changes
(2) Physical stimulation
(3) Social touch
(4) Emotional haptic design

2.5.1 Applications of Affective Haptics [12]

- Treating dejection and nervousness
- Monitoring and controlling moods on the basis of physiological signals,
- Affective and collective games,
- Testing psychology,
- Communication systems for children with autism.

2.6 Algorithms Employed

In the work on deducing and classifying human emotions, the most frequently used classifiers are Linear Discriminant Classifiers (LDC), Hidden Markov Models (HMMs), Gaussian Mixture Model (GMM), Support Vector Machines (SVM),k-nearest neighbour (k-NN),Artificial Neural Networks (ANN) and Decision Tree Algorithms. Numerous studies have decisively showed that selecting the appropriate classifier can meaningfully improve the overall performance of the system [13].

The list below gives a very brief description of each algorithm:

- LDC – Classification happens based on the value obtained from the linear grouping of the values from features, which are frequently provided in the form of feature vectors [14].

- K-NN – Classification occurs by defining the object in the feature space, and comparing it with "k" nearest neighbours. The majority vote decides the classification [15].

- GMM – is a probabilistic model used for signifying the presence of sub-populations within the complete population. Every sub-population is defined using the mixture distribution, which permits for classification of explanations into the sub-populations [16].

- SVM – is a form of (usually binary) linear classifier which selects in which of the two (or more) likely classes, each input may fall into [17].

- ANN – is a mathematical model, enthused by biological neural networks that can well grasp possible non-linearity of the feature space [18].

- Decision Tree algorithms – are based on succeeding a decision tree in which the leaves of the tree represent the classification result, and branches represent the conjunction of successive features that lead to the classification [19].

- HMMs – a statistical Markov model in which the conditions and state transitions are unavailable for the observation. In its place, the series of outputs reliant on the states are visible [20].

In the case of affect recognition, the outputs signify the order of feature vectors, which allow the deduction of states' orders through which the model proceeded. The states can consist of various risky steps in the expression of an emotion, and each of them has a probability distribution against the possible output vectors. The states orders lead to predict the affective state which we have to classify. This is one of the most frequently used techniques within the area of speech affect detection.

2.7 Artificial Intelligence and Affective Computing

At present, there is big hype in computer science and especially in the field of artificial intelligence. Inspiring the machines to learn from the data and make sensible decisions in the areas such as education, healthcare, finance and many more. There are many applications which are the combination of both artificial intelligence and affective computing.

Fig. 3 JIBO

JIBO is one of the major application which is developed by Massachusetts Institute of Technology lab of robotics [21]. It is like a Disney character that can perform many tasks like

reading a story to a child, can give voice reminders, can recognize face and do simple talks. It is working with the help of Affectiva, which is an affective computing application.

Other applications are like Pepper, which is a Japanese robot that can tell apart feelings such as joy, anger, sadness and can respond accordingly. Even Microsoft has released a tool that could reveal a person's emotions based on their photos [20].

2.8 Risks in Affective Computing

According to the science fiction classic movie " 2001: A Space Odyssey" by Kubrick and Clarke [22], a HAL 9000 computer is the central nervous system and brain of the spaceship Discovery. The computer, has spoken and pictorial abilities which exceed those of a human. It is a " thinking machine," in the logic of representing both limbic and cortical functions. This machine can pass the Turing Test [23]. In the movie, he is afraid of being disconnected so in order to keep himself safe, he kills people.

Another film "I, Robot", which is based in the future, it happens in 2035[24], wherein robots are everywhere, they help people in every field, and they are highly emotional. Even "safe rules" are made for the robots programs still robots succeed to find bugs in the rules, and finally, they become harmful to humans. Actually, according to the film "I, Robot" it can be concluded that "no rule is 100percent safe; we can always find bugs in the rules". This leads us to question whether as shall really continue this research.[1]

III. FUTURE SCOPE

3.1 Market of Affective Computing

It is likely that the affective computing market will raise from USD 9.35 Billion in 2015 to USD 42.51 Billion by 2020, at a CAGR of 35.4% from the years 2015 to 2020 [25].

Affective computing is set to revolutionize the way organizations, especially across sectors like retail, healthcare, government & defense, and academia, gather, organize, collaborate, and convey information. This is a large uprising in the global IT market and holds a very strong growth potential.

This innovative technology permits devices/machines to collect, scrutinize, and judge future outcomes and be like an advanced and intelligent system, like human brain. The system captures all dimensions of sensory vertex and other physiological changes in subjects/people under observation. Affective computing mechanism is based on the learning in the neo-cortex, a part of the human brain that plays a big role in decision making by examining the behavior of a human's and taking decisions on the basis of time series analysis.

The affective computing systems incorporate technologies including contact based and non-contact technologies and captures human emotional quotient through software methods such as facial appearance recognition, neural analytics, gesture recognition, speech recognition and other physiological recognition features, to capture, archive, and refer to existing data [25].

3.2 The Gartner Hype Cycle

"The Gartner Hype Cycle for Emergent Skills" as shown in figure 4 is the broadest Hype Cycle, which includes featuring technologies that are the emphasis of attention because of particularly great levels of interest, and those that Gartner believes have the prospective for significant impression. Betsy Burton distinguished analyst at Gartner says, "We encourage CIOs and other IT front-runners to devote time and energy concentrated on innovation, rather than just business progression, while also gaining inspiration by scanning beyond the bounds of their industry."

In the 2015 Garter Hype Cycle for Emerging Technologies (see figure 4) include the placement of "Affective Computing" in the transition phase moving towards the "Peak" wherein a lot of research focus is driving expectations from the field higher than ever before and in the next decade it is expected to peak as the technology matures and research outcomes are reported from various research groups [26].

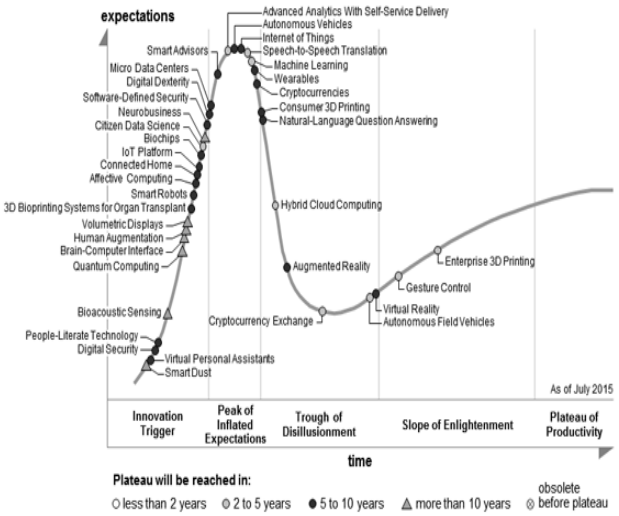

Fig. 4 Gartner Hype Cycle 2015

IV. CONCLUSION

Affective computing is a way to reach higher levels of Artificial Intelligence. After the study of human emotions, we have discussed affective computing different features, and finally we described the applications, to show the future prospects of affective computing. Human real emotions and expressed emotions are not the same each time. For example,

Humans can pretend to be happy, when they are not. This puts significant pressure on identifying human's true inner emotions. Also in the aspects of expressing affect, work needs to be done on how computers identify, handle and express emotions [1].

At another level work is required to be done for understanding how computers can really understand the meanings of user's emotions; although it seems a little step it is in fact very difficult as regards current research. There is also a good level of risk involved in the same; it is currently unclear how this risk will be handled.

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