ISSN (Online): 2230-7893
www.IJCEM.org

Deployment of Synthetic Emotions in Robotic Mechanism: A Systematic Approach

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Abstract

In this paper, we have discussed and addressed various issues in synthetic emotion that are induced in robots. Synthetic emotions in robots encourage human interaction with them and also to draw human attention. The implementation of emotions in robots helps them to appear more intelligent. By using multi agent emotions, artificial emotions are generated. They give social sense of human companionship and develop relationship between user and human. We assed and evaluated variety of aspects on emotion from psychological point of view and different subsystem that are involved in it. This study is a sketch of importance of emotions in robots and their creation by using various techniques from various perspectives and the work carried in the field of sentiment and emotion mining.

Keywords: Synthetic Emotion, Expressions, Artificial Intelligence, Virtual Humans; Emotion Mining;

Introduction

Emotions play a key role in human's way of reasoning and decision making. Emotions have an impact on humans, actions, decisions, and states. Emotion Mining is the upcoming field of science and technology which illustrates deeper insight in subconscious motivations of human beings reliably and routinely. Here the mechanism captures is unbiased, evidence-based subconscious truths. These truths helps the system to extract necessary emotions and aspects to serve the passions and aspirations of the "people" in a better way which are most important to them. With Emotion Mining establishments and industries can reach goals with greater differentiation, engagement and competitive advantage [25]. Synthetic emotion is basically how affectively synthetic expression can be developed with reference to human body [1]. If we want robots to have real intelligence so that they can communicate with humans and adapt the environment then robots need to have knowledge about emotions to a certain level. Artificial Intelligence is a worthy tool for creating emotions in robots [2]. Artificial emotion is an emerging technology and will make machine have artificial emotions. With the help of multi agent emotions engine we can generate artificial emotions [3]. Expressions and sentiments are necessary for effective communication. To Sketch and develop structured emotions in robots, researchers require methods to design and develop as well expressions with different personifications and distinctive behaviours. Such moulding of emotions allows the engagement of robots in the perspective of the Emotional Circle to develop social interaction [22].

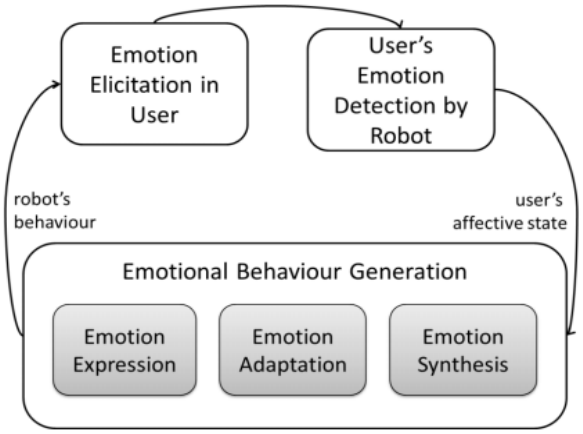

Fig.1 Human-Machine Communication Loop [9]

Synthetic emotions in robots

Emotional system in human beings plays an integral role. Similarly virtual humans will meet ways to express emotional behaviour when they face conditions such as social interaction, cooperation and learning. Therefore, a set of communicative and socio logical behaviours is associated with emotional behaviour [4]. To mimic this many researchers in the filed used robotic dog augmented with sensors and motion control circuitry. The smart robotic dog has smart and intelligent sensors and the quality digitised camera for visual aspects with two microphones in its ears. It also has IEEE 802.11b wireless

LAN which helps it controlling various activities [5]. The emotional feature augmented robots are capable of giving human beings a sagacity of societal friendship and attachments to robots. In future, synthetic emotions and emotion analysis shall be instrumental and will play a key role in the way machines intermingle with human being; various researchers such as Brea zeal's work on Kismet have tried to explore various emotional behaviours and body postures in robots. With the help of Smart Robotic dogs with sophisticated sensors and processing devices researchers explore the various ways how humans interact in different scenarios. This implementation is done to address the future robot designs and to have novelty in a set of artificial sentiments that will enhance its usability and survivability for technological progress in the field [6] [7].

Fig. 2 Robotic Dogs
[Source : https://www.digitaltrends.com]

Computing Emotional Expressions in Robots

To generate complex emotions in robots, SAIBA (Situation, Agent, Intention, Behaviour, and Animation) framework has been adopted. This framework consists of three parts: **Intent Planning** creates a Functional Markup Language (FML), specifies what a robot intend to do. **Behaviour Planning** receives the FML and produces a Behaviour Markup Language (BML), organizes and orders the behavior specified by FML. **Behavior Realization** receives the BML, interprets it as per the machine that will accomplish it, and apply the actual behaviours on top of it [8][22].

Fig. 3 Universal Model Behaviour

Few researchers used SAIBA to make the GRETA vivacious proxy which communicates with an AIBO robot (Moubayed et al., 2008) and a NAO robot (Niewiadomski et al., 2011)[22]. A system has been developed, using a mechanism that can cause exterior actions (observations) to intermingle with pre-declared BML arrangements, allowing us continuous interaction with robots. In the above figure the Behaviours Realizations phase is divided into two phases:

1. The Behaviour Scheduling phase
2. Body Execution sub phases.

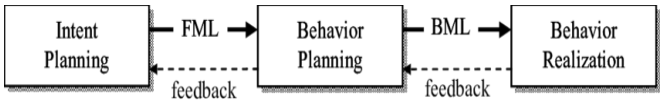

Fig. 4 The three stages of behavior generation in the SAIBA framework and the two mediating languages FML and BML [21][24]

A popular middleware ROS - Robot Operating System, works as a communication layer. This ROS-compliant robotic mechanisms can be used specially for direction finding, visualisation, or arm various operations [10].

Some robots are modelled and programmed to express certain emotional behaviour similar to that of human. These robots are used where believable and appropriate responses are required to communicate with operators at advanced level. Presence of different emotions in a robot can affect its action selection, reasoning, planning and learning processes. Different architectures are formed for different emotions. These architectures integrates drives and emotions to give the robot its behavior and decision making ability. Various mental processes are being developed on robots as more research is being done in the field. The first type of emotional architectures in robots was Cathexis, whose emotional model and action selection inspired by neurobiological theories.

The standard BDI reference model Beliefs, Desires and Intentions is a structural design that focuses mainly on representing emotional states. It mostly represents the six elementary expressive states e.g., anger, joy, surprise, sadness, disgust and fear. This prototypical is used to dictate how a responsive state is activated in a robots. The robots can use this emotion generation model to evaluation the situation or surrounding it is facing. For example, if the robot is in the designated surrounding, then the emotional result it generates is positive, i.e an emotional state of joy (as a response) and that leads to its positive behavior (as a feedback). Moreover, if the robot is not in its designated place then the emotion it generates as a result is negative (as a response), which ultimately leads to its negative behavior (as a feedback). Therefore the emotions generated by the robot will always affect the behavior it is programmed to perform. The IGrace system generates behavior in the robots by using a database of emotional experiences stored in it [11].

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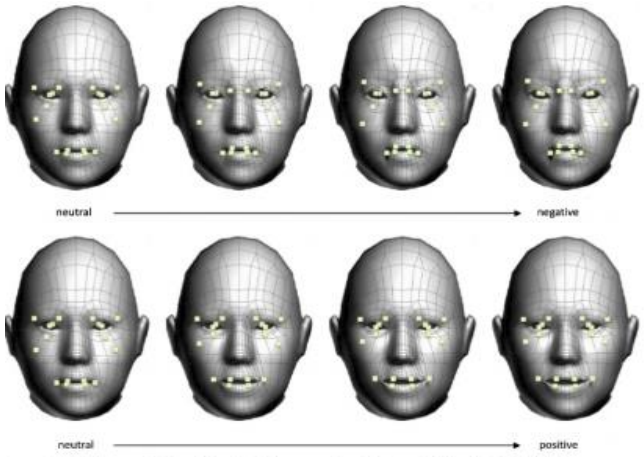
www.IJCEM.org

Facial Expressions

A Chinese female virtual human character aged 25 was created to study the various emotional expressions during a conversation. It was created with facegen and 3DsMax head movements, eye movements, facial expressions and her voice intonation were considered. The model gives the virtual human the ability to show intensity and combination of 6 basic facial expressions. The figure shows human emotions from negative to neutral then to positive [12][13].



Qu, C., Brinkman, W. P., Ling, Y., Wiggers, P., & Heynderickx, I. (2013). Human perception of a conversational virtual human: an empirical study on the effect of emotion and culture. *Virtual Reality*, 1-15.

Fig. 4 Different Facial expressions

While listening the lady shows a happy expression. In the negative condition she shows angry expression and looks away. For neutral expression the lady keeps looking at the audience. In a random condition the Chinese lady has an unstable emotional expression. The chance of being positive or negative is 50%-50% [14][23].

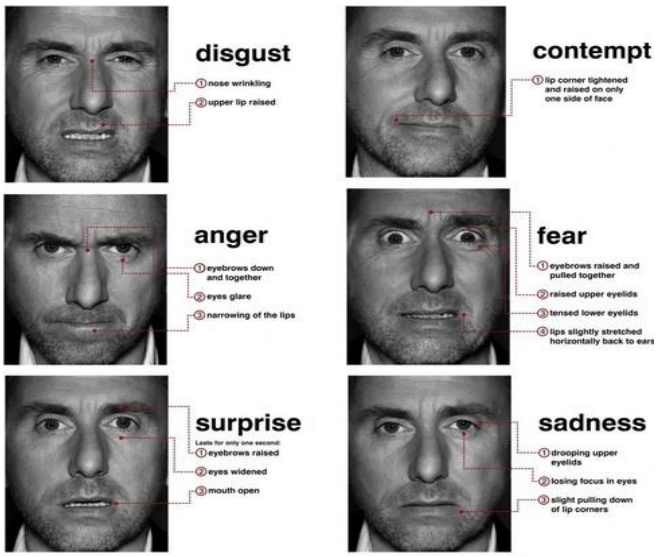


Fig. 5 Various Facial Expression
Source:http://www.dailyspeculat ions.com/wordpress/?p=6864

Speech synthesis

The four emotional states that can be synthesised using speech synthesizer are anger, happiness, sadness and neutral. To accomplish this five emotionally equitable target sentences were arranged and after that isolated speech catalogues having target diphones of above sentiments were noted. Thirty three listeners were recruited to evaluate this result by conducting listening tests. Synthesized antagonism with 86.1%, grief with 89.1%, cheerfulness with 44.2% and unbiased sentiment with 81.8% accuracy was recognised by the synthesizer. These results are not sufficient to make conclusion for happiness [16].

Building empathetic relations with synthetic agents

Synthetic emotions can be used to establish emotional relationships between users and characters because while building agents we want to achieve believability and that is done by considering 'empathy'. Empathy is basically defined as an emotional reaction of an observer because he/she perceives that another will be experiencing an emotion. So here we will come to know about the role of empathy in establishing synthetic characters and demonstrating present concepts using a system called Fear Not. Fear not is a system which was developed to address the prevalent problem of bulling in schools. Fear not uses the features of empathic synthetic characters in a 3D environment. It allows children from 8-12 classes to virtually experience the bullying situation as a third person. The factors that have been considered while establishing empathy in Fear Not are: agent's architecture, contiguity of the user and emotionally charged situations [18].

Understanding the abstract expressions of affect

To understand how the emotions in a person are shaped when a person gets affected by them and how the synthetic affective expressions can be designed a research is done. This research proposes that since affect expressions are triggered by mental processes, so we can create mental processes by providing essentials required to do so. So this kind of approach centres around 1) researches on the role of ideas in perception of a person, 2) the processes that are relevant to visual emotion recognition, 3) how synthetic emotion expression can be established using these features. A pilot study is presented to further develop this approach. This study shows how emotional contributions can be created by combining features that use abstractions instead of human configuration. This approach shows promising implementations in the designing of affective robots who can generate synthetic affective expressions. Here we find that the science behind abstract art and affect attribution research has been unified. On the basis of this research people believe that more ideas surrounding the building of abstract expressions of effect can be developed [19].

Biological functions of emotions

To understand the importance of emotional functions to practical robotics we should understand the functions of emotions in context of biology. According to Rolls(2007), emotion is not bounded by the delivery of a reward/punisher and even not by omission of reward/punisher and it acts as either optimistic or undesirable reinforcement. The provision of an incentive and oversight of retaliator is considered positive strengthening. Whereas delivery of a punisher and the omission of a reward is considered a negative reinforcement. So a person acts to avoid punishers and to get rewards. Rolls (2007) discusses six factors in evoking emotions like reinforcement exigency (delivery, oversight, interruption), intensity, reinforcement relations with a stimulus, primary reinforces of an emotion, secondary reinforces, and the possibility of active or passive responses, which may affect the evoke of emotion. Now the question arises as to why we want the robots to have emotions. According to Rolls (2005, 2007), there are nine functions that can only be fulfilled using emotions. They are as follows: Emotion is needed for evoking automatic and endocrine responses. Flexibility of emotions is facilitated by flexibility of response. It means that every emotions represents a goal and this goal can be achieved by a variety of ways. He effects of emotions are self-motivating. Communication is facilitated using emotional expression. This is usually done by disclosing the person's mental state, goals and intentions. Emotions also help to build up social bonding between parents and offspring, other members of community. After persisting for a long-time emotion can generate a mood, which affects processing of events and memory. Emotions facilitates memory storage and retrieval. Since emotions persist for a long time it can provide coherent. Emotions elicits retrieval of non-cortical memories. [20]

Conclusion

There is possibility that there may be robots in the future that can feel emotions not like humans but to a great extent. Further studies on neurophenomenological investigations will lead to structure and design emotional protophenomena of robots and robotic mechanisms so that they adhere into responsive phenomena, and hence robots can feel like humans. Fear Not! It has been quite successful as seen from the results. We conclude that while building synthetic emotions empathy should be considered and aspects such as proximity of user and emotional situations should not be neglected and factors like emotional body and facial expression should also be considered. We come to know that the scientists are on verge of designing an emotional computer which will be able to think like a person and build up trust. An AI called 'Virtual Actor' is going to come online in less than two years. According to scientists, this AI can understand what is going on and it will keep up with unfolding events. Sony is planning to create an emotional robot that can bond with humans.

Acknowledgement

We would like to express our deepest regards to all those who have provided us the insight and vision to complete this research paper and assessment study. We would like to show our gratitude towards Chancellor; Vice Chancellor, Board of Management and Higher authorities who supported throughout and shared pearls of wisdom with us during the period of our research and without whose encouragement, this would not have been possible. At the end, we would like to thank our institutional colleagues, well-wishers and friends to support us morally.

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