

# Simulation of Emotions in Cognitive Robotics

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At last time most perspective and developing field in robotics is domestic robotics being able to act and assist in human-oriented environment. This field is actual one because the world's population is ageing at a phenomenal rate (in particular in Europe, USA and Japan) and provision for elderly people is therefore one of the major emerging challenges that our society has to confront. Such assistive mobile robots must be able to learn, interact and understand like human, in particular, using emotions. So now it is very popular topic for investigations in this area is emotions.

Most of existing work in AI dealing with emotions focuses on the recognition, appraisal of emotions or mimicking their expression for human computer interaction, in particular, for Human Robot Interaction (HRI). Well known such investigations in MIT and real implementations of recognition and mimicking of emotions in some Japanese robots. But emotions may be studied in two contexts (Arbib, Fellous, 2004):

- 1) Emotional expression for communication and social coordination.
- 2) Emotion for organization of behavior (action selection, attention and learning).

In this report we focus on second role of emotions. Some works related to this view on emotions are known (e.g., by E.Vityaev, 1998; Magy Seif el-Nasr et al, 2000; R.Arkin, 2003; Guillaume Grenet and Frederic Alexandre; 2008).

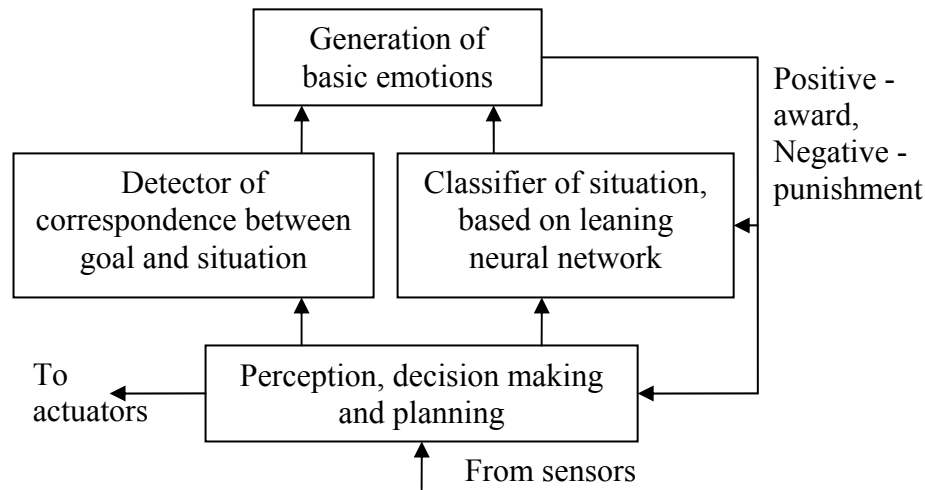
We suppose that emotions and motivations are very close. Moreover motivation is based on emotions and most sufficient reason of any activity is attraction to positive emotions and avoidance of negative emotions. On the other hand emotions are result of successful or unsuccessful achieving of goal. Thus we have just two general emotions – positive and negative. All other emotions are kinds of these basic emotions with any nuances as result of influence of state of organism (system) and features of interaction with another person.

We believe emotions influence on both selection of goal and achievement of it. The successful process of achievement of goal is reason of positive emotions and present of any unexpected obstacles is the reason of negative emotions. This concept was proposed by E.Vityaev in (Vityaev, 1998). These emotions are used for learning of person to attract or punish corresponding situations (P.Simonov, E.Vityaev). Such usage of emotions in robotics author proposed in (Gavrilov, 2008; Gavrilov 2, 2008) in couple with employ a prior knowledge for generation of these emotions to implement famous laws of A.Azimov as basis of ethic of robots. But in contrast to classic description of these laws we suggest “fuzzy” implementation of ones depending from learning like in human life.

In figure 1 our performance about connection between perception and generation of emotion is shown. We especially did not write in details unit “Perception and decision making” because this one may be implemented by different ways with hybridization of different paradigms, e.g. neural networks, reinforcement learning, fuzzy logics and so on, and this problem exceeds the bounds of this paper.

Generation of basic emotions (positive or negative) is based on recognition of “good” and “bad” situations, which may be realized by learning neural network. We suppose that the negative emotions are stimulus for changing of behavior or searching of new plan, whereas the positive emotions are not such crucial for execution of planned behavior. The positive emotions are used as award in any kind of reinforcement learning for storing successful behavior. Produced by such way basic emotion may be stored in associative memory together with any pattern describing an image or situation and may be used for building of plan to avoid or attract this pattern.

Thus in our performance the highest level of motivation for behavior and control of behavior is the generation of basic emotions - negative and positive.



**Figure 1.** The scheme of connection between perception and emotions.

Note that it is needed to distinguish any situations or objects which associate with positive or negative emotions and difference between predicted situation respecting to goal and real current situation. This difference causes basic emotions too and is recognized by detector shown in figure 1, which may be implemented by different ways using neural or logical approach. Unlike classifier of situation the detector is not learning by basic emotions. Thus generation of basic emotions must use fusion of information from two sources and detector must be more important.

To implement classifier of situation may be used multi-layer perceptron with modified error back propagation algorithm proposed by author in (Gavrilov, Lee 2007) and able to learn by both positive and negative samples. Switching of positive or negative regimes of error back propagation is caused by corresponding basic emotion.

Now we are implementing software simulation of mobile robot for solving of navigation tasks based on natural language dialog and above performance of emotion-oriented learning.

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