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AN EMOTIONAL EXPRESSION MODEL INSPIRED BY THE AMYGDALA

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Abstract. *We propose an emotional expression model, inspired by the amygdala, that governs the processing of emotional information in the brain. The proposed model can achieve two functions of the amygdala; one is the ability to discriminate among environmental sensory stimuli, and the other is classical conditioning. We verified the effectiveness of the proposed model using computational simulations. As a result, we confirmed that the adaptive and cooperative learning process of the proposed model is effective for the expression of emotions in dynamic environments. Thus the emotional expression generated by the proposed model can contribute to make robots' behavior attractive and interesting.*

Keywords: Emotion, Emotional expression, Amygdala, Classical conditioning, Self-organizing map

1. **Introduction.** Animate beings generate complex emotions based on their interaction with the environment, and can dynamically adapt themselves to any change in the environment. The emotions are interdependent with learning and memory systems of animals, and have a significant role in behavior.

Recently, the emotions and affections of animate beings have been gradually introduced into intelligent systems and autonomous robots. Affective computing, which is an area of research focusing on emotional information, is attracting increasing attention in the area of human-robot interaction [1]. For example, robots which make facial expressions of emotions have been developed with well-designed mechanisms and psychological findings [2,3]. The expression of emotions using facial expressions is effective in the improvement of communication performance between humans and robots, and impacts positively on society. Regarding the behavior of robots, a wide variety of actions are induced by internal values associated with several emotions [4, 5]. However, these emotions need to be programmed in advance. Thus the expression of emotion cannot adapt to changes in the environment. An important factor for the emergence of emotion is an adaptive recognition of sensory inputs from the environment. Accordingly, the emotions are intrinsically generated based on both a subjects own internal state and on the environment.

It is well known that emotions, especially fear, are processed in the amygdala, which is part of the cerebral limbic system, and that the amygdala is involved in fear conditioning [6, 7]. In the amygdala, the input of sensory stimuli from the environment is evaluated according to its emotional value; how strong does a stimulus affect fear or pleasure? Consequently, emotional responses to sensory stimuli are transmitted from the amygdala