Chapter 11
Mapping Artificial Emotions into a Robotic Face

Gabriele Trovato
Waseda University, Japan

Atsuo Takanishi
Waseda University, Japan

ABSTRACT

Facial expressions are important for conveying emotions and communication intentions among humans. For this reason, humanoid robots should be able to perform facial expressions which represent their inner state in a way that is easy to understand for humans. Several humanoid robots can already perform a certain set of expressions, but their capabilities are usually limited to only the most basic emotions. It is necessary to consider a wider range of expressions and take advantage of the use of asymmetry. This chapter describes these aspects as well as insights about artificial emotions models, the mapping of human face into robotic face and finally the generation of facial expressions.

INTRODUCTION

In the near future humanoid robots are expected to play a bigger role in the society, and interacting and communicating are abilities that are necessary to integrate in the society.

As communication between two humans is achieved through the simultaneous use of both verbal and non-verbal communication, humanoid robots should be able to use these two channels. As humans, we use different types of non-verbal cues, such as kinesics, proxemics, haptics, and paralanguage (Knapp, 1980). Mehrabian and Wiener (1967) were the first who underlined the importance of non-verbal communication, stating that the non-verbal channel is even more important than words when the content of the communication involves emotions.

Non-verbal communication can have different functions. It can express a mental state through the exhibition of affect displays (Mehrabian & Friar, 1969), (Patterson et al., 1986), cues about
individuals’ personality (Mehrabian & Friar, 1969), (Mehrabian, 1972), hints about the current cognitive state (Poggi, 2001), (Pelachaud & Poggi, 2002), attitude and anxiety levels (Vinayagamoorthy et al., 2006), and relations between people.

In a conversation, the complimentary information conveyed by facial expressions is useful for the interlocutor to understand the mental state of the speaker and even to detect lies (Ekman, 2009). As the face is considered the most important body area and channel of non-verbal communication (Harper et al., 1978), the expressiveness of the face is an important ability for a humanoid robot.

While a few examples of robots that can already perform a certain number of facial expressions exist, their number is usually limited to the most basic expressions (fear, anger, disgust, happiness, sadness, and surprise) and the patterns are pre-defined. There is a need to go beyond this traditional approach, and rather map the artificial emotions into the robotic face. This parametrical approach would make the robot able to display composite emotions. Moreover, the same concept could be extended to the generation of facial expressions which represent not strictly emotions, but are rather communication acts (such as incomprehension or rebuke) that usually are present during a conversation.

Quality of expressions can be improved taking asymmetry into account. Human face is often not symmetrical over the central vertical line. Both emotional expressions and the face at rest can show signs of asymmetry. In character animation, asymmetry is an important way of making a drawn character not appear stiff and still (Thomas & Johnston, 1995). We want to use asymmetry on the robot to produce expressions that look more natural, and thus are more easily recognised. In case of 3D avatars, implementation of asymmetry in a facial generator has been already attempted (Ahn et al., 2010), (Ahn et al., 2011). However, to the best of our knowledge, there is no study been done so far on asymmetry in a robotic face.

Objectives of the Chapter

In this chapter we describe the mapping of emotions into the face of the humanoid robot KOBIAN-R through the mapping of human face into the robotic face and a system that generates facial expressions, selecting an appropriate combination of facial cues. While the correspondence to facial cues itself is specific for KOBIAN-R, the artificial emotions and communication acts model that has been made can potentially be used on other robots. The generator is based on polynomial classifiers and on relevant studies of psychology and facial anatomy. In its extended form, it is capable of generating asymmetrical expressions. Some expressions produced by the generator are shown as well as the results of an experiment of evaluation of asymmetrical facial expressions, with the purpose of understanding when the use of asymmetry is appropriate among various emotions. The topics explained in this chapter have been introduced from different points of view in (Trovato et al., 2012), and (Trovato et al., 2013).

The rest of the paper is organized as follows: in the section “Background” we digress into the state of the art; in the section “Facial Expressions Generation” we introduce the hardware used, the mapping of emotions and the generation of expressions and the implementation of asymmetry; in the section “Future trends” we discuss of limitations and new directions of research; finally in “Conclusions” we summarise again the chapter.

BACKGROUND

Robots Performing Facial Expressions

Facial expressions can already be performed by a certain number of robots, including iCub (Beira et al., 2006), Albert HUBO (Oh et al., 2006), WE-4RII (Itoh et al., 2004), and KOBIAN.