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Int. J. Human-Computer Studies 62 (2005) 179–192

International Journal of  
Human-Computer  
Studies

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# Subtle emotional expressions of synthetic characters

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Available online 2 January 2005

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## Abstract

This study examines the influence of the geometrical intensity of an emotional facial expression on the perceived intensity and the recognition accuracy. The stimuli consisted of synthetic faces at ten geometrical intensity levels in each of the five emotional categories. A curve–linear relationship was found between geometrical and perceived intensity. Steps of 20% geometrical intensity appear to be appropriate to enable the participants to distinguish the intensity levels. At about 30% geometrical intensity the recognition accuracy reached a level that was not significantly different from each emotions maximum recognition accuracy. This point indicates a categorical perception of the facial expressions. The results of this study are of particular importance for the developers of synthetic characters and might help them to create more subtle characters.

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## 1. Introduction

Many synthetic characters are used for entertainment, communication, and work. They range from movie stars (Thomas and Johnson, 1981) and pets (Sony, 1999)

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Fig. 1. Aibo, eMuu and microsoft agent.

(see Fig. 1) to helper agents (Bell et al., 1997) (see Fig. 1) and avatars for virtual cooperative environments (Isbister et al., 2000). Characters can also have a physical body, e.g. robots. The range of robots is very wide and therefore this paper focuses on robots that interact with humans and not on industrial or military robots. The interesting robots for this study help the elderly (Hirsch et al., 2000), support humans in the house (NEC, 2001), improve communication between distant partners (Gemperle et al., 2003) and are research vehicles for the study on human–robot communication (Okada, 2001; Breazeal, 2003). A survey of relevant characters is available (Bartneck, 2002).

The ability to communicate emotions is essential for a natural interaction between characters and humans because it is not possible not to communicate. The absence of a character's emotional expressions could already be interpreted as indifference towards the human. Therefore, it is important that characters express their emotional state. Some of these characters can express emotions to improve the interaction between the character and the user (Bartneck, 2003; Breazeal, 2003) (see Fig. 1) or to visually support synthetic speech (CSLU, 1999). The CWI institute in Amsterdam developed a talking screen character that is able to express emotions based on an emotion disc (Ruttkay et al., 2000).

Three parameters and their interaction are important for the design of emotional expressions for characters: geometrical intensity, perceived intensity and recognition accuracy. We will now take a closer look at the three parameters.

### 1.1. Geometrical intensity

The synthetic face has certain components, such as eyebrows and a mouth, which can be manipulated. Usually, a maximum for each emotional expression is defined by reproducing already validated faces, such as the well-known Ekman faces (Ekman and Frieser, 1976). The spatial difference of each component between the neutral and the maximum expression is then divided into equal parts. To express 30% happiness, for example, the components are moved 30% of distance between neutral and maximum.

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