Demonstration – First Steps in Emotional Expression of the Humanoid Robot Nao

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ABSTRACT

We created a library of emotional expressions, and not an emotional system, for the humanoid robot Nao from Aldebaran Robotics. This set of expressions could be used by robot behavior designers to create advanced behaviors, or by an emotion simulator. It is an insight into a conjoint work between an invited anthropologist and robotics researchers which resulted in about a hundred animations. We do not provide a review of the literature.

Categories and Subject Descriptors

I.2.9 [**Artificial intelligence**]: Robotics – *Commercial robots and applications.*

General Terms

Design, Experimentation.

Keywords

Expressive robot behaviors, emotional expression, humanoid robot, Nao, demonstration, Choregraphe.

1. INTRODUCTION

Nao is a humanoid robot whose description is available in [5]. This paper introduces the first works realized by Aldebaran Robotics to obtain a behavior library dedicated to the expression of emotions by Nao (which only mimics the emotions). Such behaviors will boost the entertainment potential of Nao. We also believe that future humanoid service robots will be more easily accepted by people if they are able to express emotions naturally.

2. CONTEXT

It can be tedious to create a humanoid robot behavior. To ease this, Aldebaran Robotics has developed graphical user interfaces that enable the access to a set of small behaviors usable as building blocks in a bigger behavior by an inexperienced user.

Expressive behaviors use joint movements, the lighting system and sounds. The humanoid shape facilitates the creation of expressive movements the viewer instinctively understands. However there are differences between the expression means of Nao and of a man that compel the behavior designer to use specific ways to make the robot expressive, often at the expense of the behavior's understandability. Caricature can compensate this. New issues are thus raised: how do you relate emotions to eye color? How does a robot without a mouth smile?

3. EMOTIONAL EXPRESSION ISSUES

The emotional typologies are often summoned as premises and thus are seldom put into question. They set up convenient lists that are useful to provide machines with lists of base emotions. Actually, the development and use of typologies generate a paradox that emphasizes a conflict between mimesis and techne [1], that is between the observation of nature and its transposition in an object by means of a technology. The communicational issue therefore lies in a formulation of the meaning, as it should emerge from the object. It refers to a link between a codification of the object and the inference from the subject [9]. Solutions are to give the gesture morphology a minimal structure based on interpolated keyframes, and to limit our corpus according to the expressive, meaningful qualities of the emotions to figure out and so to focus on the communicational aspect of the animation.

4. METHODOLOGY

Communication through image is possible because image shapes up the essential attributes of the action it represents. These attributes develop according to a framework the artist extracts from the general representations of the action such as the ones he assumes the existence in the viewer's mind [4]. We must codify the somatic image to promote a correct inference from the viewer. The methodological issue that arises is that of extraction, nature and models of the expressive movements, or of optical saliences that promote a correct inference of the perceived movement. As elsewhere vindicated, we ignore the creation process of the gesture in favor of its externalized parts [6]. Our technique involves imitation by direct observation, the isolation

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of the main steps of the movement to achieve, and the adjustment of each of these elements, to Nao's morphology and by human contact. We do not search archetypes, but we explore significant icons that illustrate the emotional movements to imitate.

5. GESTURE LIBRARY

About 40 of our behaviors are related to about 15 emotional states themselves categorized alongside an axis going from pleasure to displeasure through neutrality. Our library has been built with a combination of elementary typological elements [2] and by making the robot interact with a user. The aim was to enable the user to infer inner states to Nao. Then we searched for variations of duration and intensity.

Table 1. Distribution of the main states to animate

Pleasure	Neutrality	Displeasure
Elation (fig.2)	Waiting (fig. 3)	Disgust
Happiness (fig. 1)	Surprise	Tiredness
Amusement	Concentration	Sulkiness
Tease	Neutrality	Anger
Interest	Need for attention	Sadness
	Boredom	Pain

Figure 1. On-going: Happy

Figure 2. On-going: Laughing

Figure 3. Final state: Waiting

6. SOUND DESIGN

The movements had to be accompanied with sounds the user would easily recognize. For the sake of consistency, we sought to use sounds similar to those a being the size of Nao would produce, such as high-pitched samples, as the text-to-speech cannot produce onomatopoeia. The risk is to build a quixotic image that foster a feeling of uncanniness [8]. The sounds differ according to the duration and intensity of the animations.

7. EYE ANIMATION

To underline the uniqueness of each behavior, we animated the eye LEDs. We created a code that was integrated in the movement sequences. We will not explain this code in depth. Associating colors with emotions raises many issues as it is linked with traditions related to esotericism and the history of a theory of color in art [3]. This association is arbitrary and it may be better thus. The codification of the LEDs shapes and colors thereby seems to belong only to Nao.

8. VALIDATION

This work does not rely on a strict experimental framework but rather on an observation on the fly of the effect these animations produce in demonstration. However we are aware of the importance of evaluating the readability of our animations. We will have to validate the library with a multicultural public. Indeed, our animations could be wrongly inferred according to the viewer's culture, if we consider the cultural character of non-verbal expression and so the cultural variations in communicational behaviors [7]. We may have to localize some animations. The context might affect the inference of emotions. Subtle behaviors will be difficult to guess out of context without expressiveness tools such as eyebrows.

9. CONCLUSION

We would like to reiterate that we have not tried to create an emotional system, but to provide behavior designers with a library a future emotion simulator could also use. The difficulty to find a universal code and the morphological differences between a human and a tiny robot require a specific approach.

We have not addressed interaction, but we intend to deal with it. By recreating an interaction situation closer to the man-man one that the user is accustomed to, we will encourage him to behave in a natural way that is easier to detect by Nao. Nao can detect human beings thanks to sensors and algorithms such as speech recognition, face detection or sonars. We will also develop more complex detections (human emotion...). Besides we intend to work with professional animation artists. Aldebaran Robotics is seeking other mechanisms of expression in the GV-Lex project (French National Research Agency project) in which an expressive text-to-speech is developed.

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