

Various Emotional Expressions with Emotion Expression Humanoid Robot WE-4RII

Kazuko Itoh¹, Hiroyasu Miwa², Munemichi Matsumoto¹, Massimiliano Zecca^{3,4},
Hideaki Takanobu^{5,6}, Stefano Roccella³, Maria Chiara Carrozza³, Paolo Dario³, Atsuo Takanishi^{2,4,6}

1 Graduate School of Science and Engineering, Waseda University, Tokyo, Japan, itoh@suou.waseda.jp

2 Department of Mechanical Engineering, Waseda University, Tokyo, Japan, takanisi@waseda.jp

3 ARTS Lab, Scuola Superiore Sant'Anna, Pontedera, Italy

4 ROBOCASA, Tokyo, Japan

5 Department of Mechanical Systems Engineering, Kogakuin University, Tokyo, Japan

6 Humanoid Robotics Institute, Waseda University, Tokyo, Japan

Abstract- The authors have been developing humanoid robots in order to develop new mechanisms and functions for a humanoid robot that has the ability to communicate naturally with a human by expressing human-like emotion. In 2004, we developed the Emotion Expression Humanoid Robot WE-4RII (Waseda Eye No.4 Refined II) by integrating the new humanoid robot hands RCH-1 (RoboCasa Hand No.1) into the Emotion Expression Humanoid Robot WE-4R. We confirmed that WE-4RII can effectively express its emotion.

Keywords- Humanoid Robot, Robot Hand, Emotional Expression
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I. Introduction

It is anticipated that the personal robots become popular in the future. The personal robots are required to actively behave in joint work and community life with humans and adapt to partners or the environment. Therefore, we have been developing new mechanisms and functions for a humanoid robot that has the ability to express emotions and to communicate with humans in a human-like manner.

The authors have been developing the WE (Waseda Eye) series since 1995. Coordinated head-eye motion with Vestibular-Ocular Reflex, depth perception using the angle of convergence between the two eyes, a colored visual sensation system and four sensations (visual, auditory, cutaneous and olfactory sensation) were achieved [1]. In 2004, we developed the Emotion Expression Humanoid Robot WE-4RII (Waseda Eye No.4 Refined II) by integrating the humanoid robot hands RCH-1 (Robo Casa Hand No.1) [2] into WE-4R [3] in order to improve the robot emotional expression and realize interaction between human and robot. In this paper, we describe the various emotional expressions with WE-4RII.

II. Emotion Expression Humanoid Robot WE-4RII

WE-4RII has 59-DOFs (Degrees of Freedom) and has four of the five human senses (the visual, auditory, cutaneous and olfactory senses). RCH-1 is designed and developed by ARTS Lab, Scuola Superiore Sant'Anna. RCH-1 has five fingers and six active DOFs and 10 passive DOFs. WE-4RII can express its emotion using the upper-half body motion including the facial expression, arms, hands, neck and waist motion. We considered that the

motion velocity is as important as the posture in emotional expression. Therefore, we controlled both the posture and the motion velocity to realize the effective emotional expression. For example, WE-4RII moves its body quickly for surprise, but it moves its body slowly for sadness. Fig. 1 (a)-(g) shows the emotional expressions exhibited by WE-4RII. We defined the emotional patterns from the results of pre-experiment. Where, we showed the several simulated emotional patterns by 3D-CG to several subjects. We adopted the patterns with the highest recognition rate.

III. Experimental Evaluation

We measured the recognition rate of the emotional expressions of WE-4RII to evaluate how WE-4RII transmits its emotions. We showed 18 subjects (averaged age: 21) the movies of the six basic emotional expressions exhibited by WE-4R and WE-4RII. In the movies, WE-4R and WE-4RII show the same motion patterns excepting the hand motion. The subjects chose an emotion that they felt that the robot expressed. Then, we examined the correct recognition rates of those emotional expressions. In addition, we compared the recognition rates of WE-4RII to WE-4R. The experimental results are presented in Fig. 2.

As a result, we considered that these emotional expressions except "Fear" were sufficiently effective. The recognition rate of "Fear" was lower than WE-4R's rate because the some subjects considered the "Fear" as "Disgust". We also measured the recognition rate of several extra emotional patterns shown in Fig. 1(h)-(l), because human's emotional expressions are always different even if the human emotion is same. Most of the subjects felt that pattern 1 shows "Sadness", pattern 2 shows "Surprise", pattern 4 shows "Anger" and pattern 5 shows "Happiness". But, they answered that pattern 3 could have several emotion or meaning according to the situation. Therefore, we considered that WE-4RII could express its emotion by several patterns.

IV. Conclusions and Future Work

We developed the Emotion Expression Humanoid Robot WE-4RII (Waseda Eye No.4 Refined II) by integrating the humanoid robot hands RCH-1 (Robo Casa Hand No.1) into WE-4R. We confirmed that WE-4RII had effective emotional expression ability through the experimental

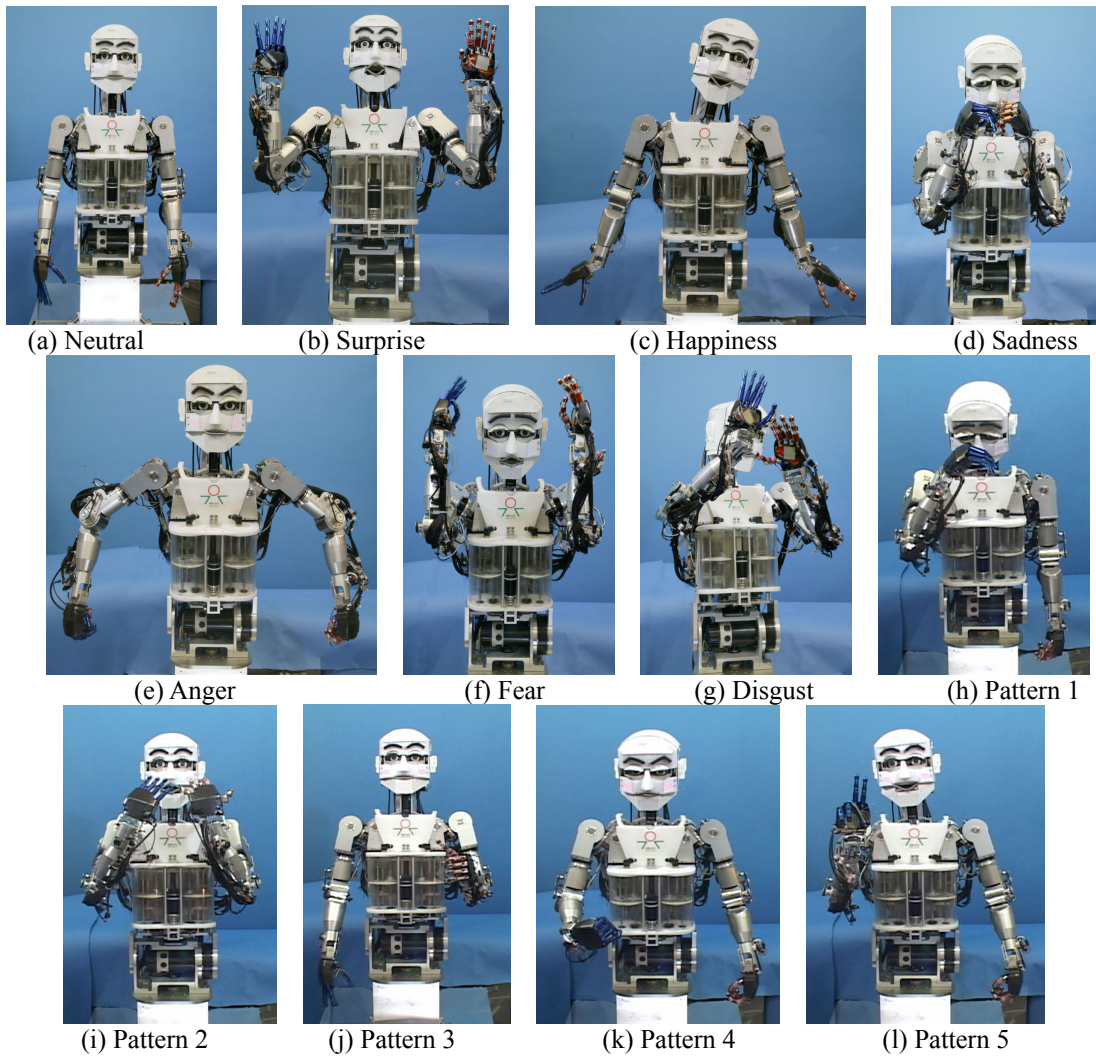


Fig. 1 Emotional Expressions of WE-4RII

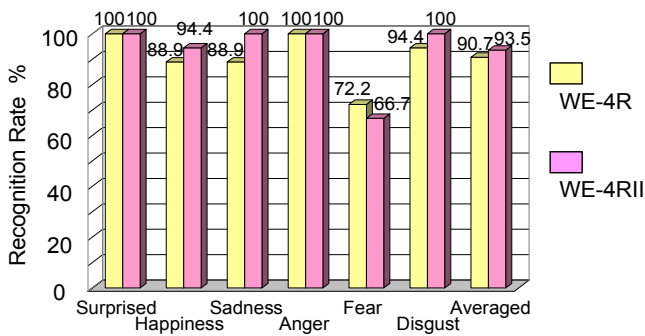


Fig. 2 Results of Experimental Evaluation

evaluations with questionnaire method. At first, we consider that the personal robots will be used in the future as a guide, a salesperson and so on. One of most important things for such workers is emotional expression. We would like to increase the emotional expression patterns and provide a humanoid robot with the mechanisms and functions to express emotions.

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References

- [1] H. Miwa, et al: "Development of a New Human-like Head Robot WE-4", Proceedings of the 2002 IEEE/RSJ International Conference on Intelligent Robots and Systems, pp.2443-2448, 2002
- [2] S. Roccella, et al: "Design, fabrication and preliminary results of a novel anthropomorphic hand for humanoid robotics: RCH-1", 2004 IEEE/RSJ International Conference on Intelligent Robots and Systems, to appear
- [3] H. Miwa, et al: "Design and Control of 9-DOFs Emotion Expression Humanoid Arm", Proceedings of the 2004 IEEE International Conference on Robotics and Automation, pp.128-133, 2004