Robot Sharing Human Emotion for Improving Relationships Based on Facial Expression Recognition

Sakmongkon Chumkamon*, Hongmin Wu*, Juan Rojas* and Eiji Hayashi†
*School of Mechanical and Electrical Engineering, Guangdong University of Technology
†School of Computer Science and Systems Engineering, Kyushu Institute of Technology
Email: s.chumkamon.jp@ieee.org

***Abstract*—This poster presents the cognitive process of the animal robot with emotional intimacy when robot recognizes a human. The robot behavior was built based on hierarchical artificial consciousness depending on its motivation. The point of this poster is emotional intimacy of robot when robot interacts with a human. Since the robot has an interpersonal relationship of emotion, a robot would have a closer relationship and trust. This paper focuses on three points in the development of our proposed framework: (1) the organization of the behavior including inside-state emotion regarding the phylogenetic consciousness-based architecture; (2) the method whereby the robot can have empathy toward its human user's expressions of emotion; and (3) a method that enables the robot to select a facial expression in response to user's expression, based on biologically inspired topological online method.**

Keywords-Emotional Intimacy; Human-Robot Interaction; Facial Expression Recognition; Consciousness Based Architecture

I. OVERVIEW OF ROBOT SYSTEM

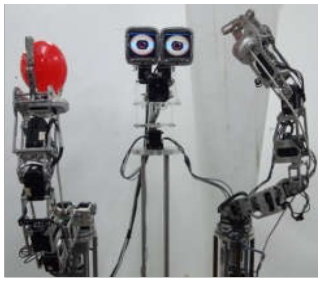

Figure 1. Conscious Behavior Robot

In the human-robot interaction of personal robot, most robot operates by depending on a human. Because robot does not have a process like animal nature such as consciousness and mind, it cannot behave lifelike. Therefore, we focus synchronizing robotic action with a consciousness based architecture (CBA) system and the artificial intelligence (AI). CBA is to create the process of the consciousness, and AI is for memory and recognition system. We apply the robotics system namely CONBE (Conscious Behavior) robot in Fig 1. including the cognitive. We highly propose the combination aspect of the mind and brain because both systems originate an animal being as we know [1], [2]. In our robot, the mind is functioned by the CBA, and the biological brain is performed by Topology Learning Adaptive Resonance Theory [3] because the method relies on the consciousness aspect. Moreover, since the human is the social animal that coexists with each other, we thus implement the robot with the ability of emotional skill to have a close relationship with a user. With this system, the robot should coexist with human and without the conflict because the robot could express its emotion respecting human emotion. For instance, when robot and human have opposite emotion that can occur the emotional conflict. The system is implemented based on the robot namely CONBE (Conscious Behavior) robot.

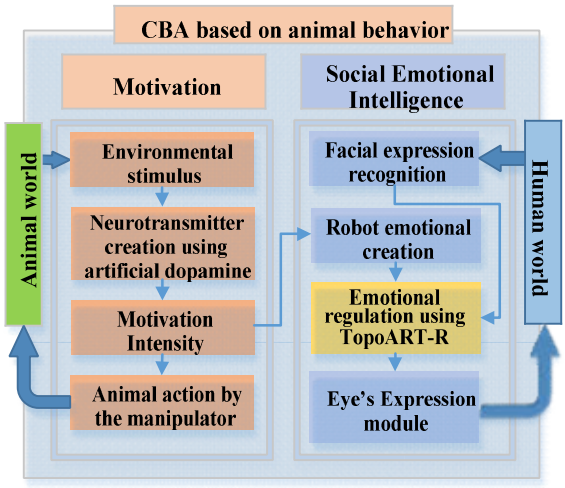

Figure 2. The overview of the proposed methodology.

The robot system is composed of two major part. First is animal perception. Second is human expression recognition for cross-commination. Firstly, we create the behavior robot as animal based on the CBA that has the motivation and the dopamine as a major factor. The dopamine is created when the robot recognizes the object depending on color and shape. For the emotion system, the artificial dopamine is used to induce the motivation which can be negative and positive. The robot emotion is generated by motivation.

For facial expression recognition, the robot comprehends the emotion from the user. In this paper, FER system composed of the facial feature extraction by the constrained local model (CLM), and emotional expression classification by Hidden Markov Model (HMM) to process FER [4]. Afterward, the output of FER will feed to emotional intelligence regulation system to consider the proper expression that based on the

user's expression and robot inner emotion. Emotional generation determines the output expression by calculating the average of emotion between robot and user's emotion. We distinguish the emotion from the most positive as a surprise and most negative as anger. However, the factors of robot expression are not only the emotion from robot and human, but it also includes surrounding objects, dopamine, and motivation which are the inside states. Consequently, we apply the biologically inspired method which is Topology Learning Adaptive Resonance Theory (TopoART). The method is closely related to the cognitive and neural theory of the brain instinct learning categorizing recognition, prediction, and the topology relates to consciousness process, expectation, attention, resonance, and synchronization between unsupervised and supervised learning [5]. TopoART can perform the real-world information which is dynamic and variant because it is the on-line incremental method that can carry out the stable learning fast.

II. EXPERIMENTAL RESULTS

We demonstrate the robot behavior, emotional generation based on human's expression. The top of Fig. 3 shows each parameter in the experiment including the motivation based on dopamine aroused by object recognition. The bottom presents the robot inner emotion, human's emotion and the robot expression in the task period. Fig. 4 shows the capture images of FER and the robot's expression during testing, Fig. 5 is the capturing images that the user also plays with the robot using the ball stimulating on each time from T0 to T5.

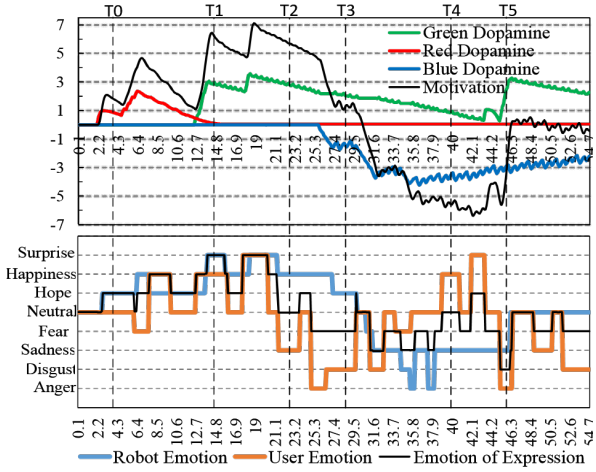

Figure 3. The robot's motivation and emotional expression

When robot starts, it feels neutral and expresses neutral according to the motivation, when the favorite red object is recognized the motivation increased. On T0, the robot feels hope according to increased motivation, and human expresses neutral, then it expresses hope due to encouraging human feeling. On T1, robot feels surprised because the most favorite green is recognized suddenly and human expresses hope then robot expresses surprise. On T2, the robot is happy but the human expresses sad then robot expresses neutral and masks its happiness because of emotional conflict. On T3, the robot is hope, but human disgust robot then expresses fear. On T4, the robot is sad, but the human is happy, the robot then expresses neutral and mask its sadness due to sharing emotion. On T5, the robot is sad and human is angry then robot expresses disgust due to the emotion sharing.

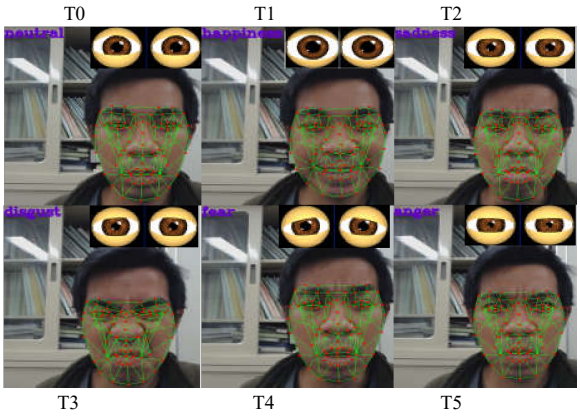

Figure 4. Robot eye's expression and human's expression.

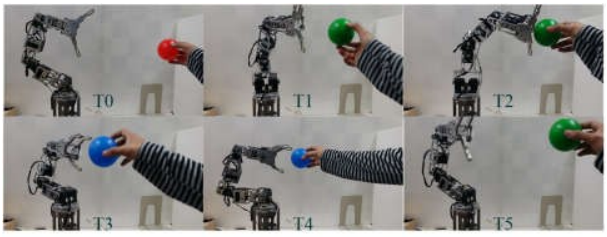

Figure 5. The captured images of robot behavior during dopamine and motivation activating.

V. CONCLUSION

This poster presents the system of the cognitive behavior robot and emotional sharing between an inside state of the robot and user's expression by face-to-face. Our preliminary evaluation demonstrates that the robot can perform its behavior and inner emotion depending on the dopamine and motivation. When the robot can recognize a user, it can present the expression that is regulated by sharing the robot emotion and user's expression to avoid an emotional conflict. Where the system implemented the hierarchical consciousness based on the motivation model, facial expression recognition, and emotional generation using an incremental on-line learning algorithm to allow the robot can learn the new pattern continuously based on the consciousness aspect.

REFERENCES

[1] S. Chumkamon, K. Masato, and E. Hayashi, "Facial Expression of Social Interaction Based on Emotional Motivation of Animal Robot," in *Systems, Man, and Cybernetics (SMC), 2015 IEEE International Conference on*, 2015, pp. 185–190.

[2] R. M. Young, "The mind-body problem," 1990.

[3] H. Robinson, "Dualism," *Stanf. Encycl. Philos.*, Nov. 2011.

[4] M. Tscherepanow, "An extended TopoART network for the stable online learning of regression functions," in *Neural Information Processing*, 2011, pp. 562–571.

[5] S. Chumkamon and E. Hayashi, "Facial expression recognition using constrained local models and Hidden Markov models with consciousness-based architecture," in *System Integration (SII), 2013 IEEE/SICE International Symposium on*, 2013, pp. 382–387.