Artistic Robot *Please Smile*

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CHI'12, May 5–10, 2012, Austin, Texas, USA.
ACM 978-1-4503-1016-1/12/05.

Abstract
This paper explains how people interpret artistic robots as more than mere machines in the theory of intentionality and introduces the implementation of the artistic robot, *Please Smile*, which consists of five robotic skeleton arms that gesture in response to a viewer's facial expressions.

Author Keywords
Artistic robots, computer vision, robotic arts, skeleton arms, smile detection

ACM Classification Keywords
D.2.6. [Software Engineering]: Programming Environments--interactive environments; H.5.2. [Information Interfaces and Presentation]: User Interfaces--interaction styles; I.5.4. [Pattern Recognition]: Application--computer Vision

Introduction
With reductions in manufacturing costs in innovative technology, robots are becoming pervasive in our homes, schools, amusement parks, museums, and hospitals. [4]

In addition to a transition toward lifestyles of convenience and increased demands for robots in these domains, the use of robots has expanded to interdisciplinary fields that cover the design of

mechanical and electrical components, sensor technology, computer systems, and artificial intelligence [5].

The most common definition accepted by many writers is from the Robot Institute of America, which describes a robot as "a reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks without human intervention" [6]. This definition discusses the functionality and control of primarily industrial robots. However, we can explore robots on a more personal level according to their functions, features and relationships with people, which are often acknowledged when audiences appreciate them as art forms. This paper discusses how people interpret artistic robots as more than mere machines using the psychological theory of intentionality; it also introduces the implementation of the artistic robot, *Please Smile*, and explores how developers apply their ideas to experimental design form to create artistic robots that differ from the traditional perspective of practical robots.

Theory of Intentionality

A philosopher and psychologist in the 19th century, Franz Brentano introduced the concept of "intentionality" used in philosophy and cognitive science to explain why people believe that machines can think without any human level intelligence. To explain mental phenomena, he used to phrase "intentional inexistence" [1]. According to Brentano's perspective, people have beliefs because certain objects trigger certain attitudes and behaviors. The view is also supported by philosopher Daniel Dennett [3] in Intentional Stance. In his view, people applied three strategies to predict the behaviors of living organisms such as plants, animals, humans, and even artifacts. Whereas some are based on the laws of physics (e.g., "If you leave the water at less than 0 C., the water will freeze."), others are determined by design (e.g., "The design of a cup gives clues about how to grab the cup."). Sometimes neither the physical nor the design stance is accessible, so the intentional stance can be adopted. Followed by Dennett's view, the intentional stance applies plants, animals, humans, and artifacts as rational agents with beliefs and desires in order to predict how they are going to behave. In the same way, humans impose more meanings to a robot's perceived behaviors and movements when the robot exhibits subtle predictable cues, so humans perceive robots as more intelligent agents, not like mere automatic machines but more like autonomous humans.

Implementation

Interaction

Figure 1. Please Smile *points at the human and follows his/her movements.*

Figure 2. Please Smile *waves their hands.*

Please Smile combines artistic concepts and engineering technology to create a robot that interacts with humans. Compared to the traditional perspective of practical robots for manufacturing purposes, this new perspective of the artistic robot enables audiences to interact with robots on a more personal level and appreciate their aesthetic value as works of art.

Please Smile contains five robotic skeleton arms that change their gestures depending on a viewer's smiling facial expressions. It consists of a microcontroller, a camera, a computer, five external power supplies, and five skeleton arms, each with four motors for robots' fingers, wrist, and shoulder possessing 4 degrees of freedom (DOF). It incorporates elements from mechanical engineering and computer vision perception to create a more expressive robot. Audiences interact with *Please Smile* in three different ways. When no human falls within the view of the camera, the five robotic skeleton arms choose the default position, which is bending their elbows and wrists towards the wall behind them. When a human steps within the view of the camera, the arms point at the human and follow his/her movements (Fig. 1). Then when someone smiles in front of it, the five arms wave their hands (Fig. 2). With these interactions, *Please Smile* fosters audiences' positive behaviors such as smiling.

Hardware

Please Smile is composed of five skeleton arms, each of which uses four servo-motors. These arms are controlled by a set of PWM (pulse-width modulation) signals generated from a timer interrupt service routine in a microcontroller. We employ the ATMEL ATmega 128 microcontroller because of its sufficient number of ports. The firmware inside the microcontroller receives data from the Smile Detector (SD) program through UART communication, generating PWM signals based on the data.

Software

The SD program is a perception module in which computer vision technique is implemented. The Sony PlayStation Eye camera is used as the imaging sensor since it is inexpensive yet has adequate quality. From the sequence of images of the camera, SD program (Figure 3) first detects frontal faces [8], and then the detected face regions are evaluated through our smile detection function. The function is trained in the support vector machine (SVM) algorithm in which histogram of gradient (HoG) [2] features are used as feature vectors. For training the SVM, we prepared training data from Genki-4K dataset [7], which contains 4,000 faces, smiling labels, and head poses. Since the faces are not preprocessed enough, we cropped the frontal face regions from the dataset using the head pose data. With HoG features defined as 6 X 6 cells

and 8 X 8 blocks, our smile detection function showed 95.5963% accuracy.

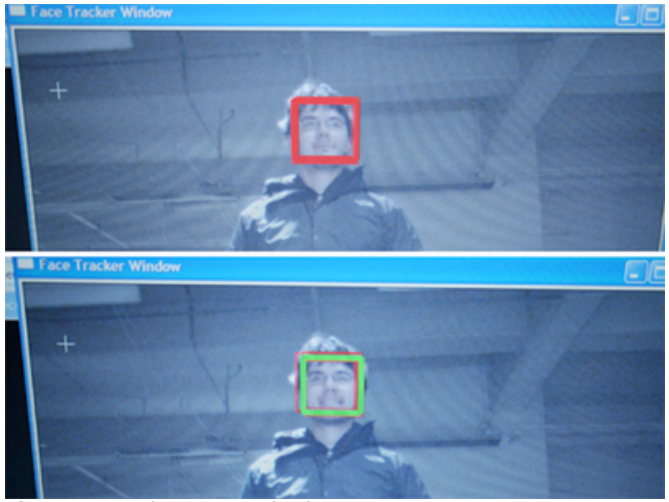

Figure 3. Smile Detector (SD)

Conclusion

Please Smile was exhibited at Buffalo Arts Studio, United States, FILE festival at Sao Paulo, Brazil in 2011 and 3rd Ward, United States in 2012. Hundreds of participants interacted with this artistic robot, and in their comments, they stated that it was sometimes "friendly and nice" but also sometimes "scary and creepy." Because *Please Smile*'s reactions to audiences' facial expressions imitate the movements of intelligent agents, it triggers people's imaginations and interpretations of intentionality, rendering the robot more human-like.

Acknowledgements

This work is supported by the Next Generation Design Leaders Program, which is funded by the Korean Ministry of Knowledge and Economy (MKE) and administered by the Korea Institute of Design Promotion (KIDP).

References

[1] Brentano, F. *Psychology from an Empirical Standpoint*. Routledge, London and New York, 1995.

[2] Dalal, N., Triggs, B. Histograms of oriented gradients for human detection, *in IEEE Conference on Computer Vision and Pattern Recognition*, (San Diego, CA, USA, 2005), IEEE CS Press, 1. 886-893.

[3] Dennett, D. C. *The Intentional Stance*. The MIT Press, 1989.

[4] Dodd, J. Robots: The New "Steel Collar" Workers. *Personnel Journal*, 60. (1981). 688-695.

[5] Fu, K. S., Gonzalez, R. C., and Lee, C.S.G., *Robotics: Control, Sensing, Vision, and Intelligence*. Mcgraw-Hill Book Company, 1987.

[6] Hunt, H. A., Hunt, T.L. *The Robots are Coming.* Upjohn Institute Press, Kalamazoo, MI, 1983.

[7] The MPLab GENKI Database, GENKI-4K. Retrieved February 26, 2012, from Machine Perception Laboratory, University of California, San Diego: http://mplab.ucsd.edu/.

[8] Viola, P. and Jones, M. J. Robust real-time face detection, *International Journal of Computer Vision*, 57 (2). (2004). 137–154.