Towards Natural Emotional Expression and Interaction: Development of Anthropomorphic Emotion Expression and Interaction Robots

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ABSTRACT

In present research the advanced fundamental mechanical capabilities of anthropomorphic robots developed in Takanishi laboratory at Waseda University are to be enhanced in order to enable these robots to interact with humans in a natural way. The anthropomorphic robot KOBIAN is able to express human-like facial expressions and whole-body gestures. It is equipped with vision and audio sensors that allow it to react to interaction input from human partners and to generate an appropriate emotional expression response. Furthermore, the anthropomorphic flute playing robot WF-4RVI is technically able to perform a musical wind-instrument performance at the level of an intermediate human player. Using this fundamental technical capability the authors implemented a musical-based interaction system (MbIS) that enables the robot to collaboratively play together with human musicians in a natural way. For both of the introduced interaction systems, the authors present and discuss the result of various experiments that were done to examine how well the interaction with a robot resembles realistic human-to-human interaction.

Keywords: Anthropomorphic Robot, Human-Robot-Interaction, Musical Performance Robot, Musical-Based Interaction System (MbIS), Whole-Body Expression Robot

1. INTRODUCTION

1.1. The Purpose of Robots with Emotional Expression

Since the 1960’s industrial production processes have become more and more automatized. The development of industrial robots has helped to improve production quality and production speed in many industry areas. Rapid development has taken place in the car industry, where from the late 1970’s production processes like welding and painting of car parts has been strongly accelerated by the use of robotic arms equipped with the respective production tool. In other areas like the IT industry, robots rapidly assemble complex electronic devices with high accuracy. Through the use of vision analysis...
systems and other sensory equipment, production quality can be asserted to a high level.

More recently, there have been several attempts to introduce robots also in areas where they come into direct contact with people (Figure 1). Apart from scientific research, one of the starting points of this development was the toy industry in the 1980’s. Further development has established robots in households to perform everyday tasks like dust cleaning. In places more inviting to innovation such as trade fairs or art exhibition spaces, robots have been used as visitor guides and information terminals. Furthermore, development efforts worldwide are intending to push robot technology to perform medical treatment tasks and patient care. With the prospect of elderly societies in several developed countries, one important future field of application of robot technology is in health and welfare care.

1.2. Established Concepts in Human-Robot-Interaction

As soon as a robot is expected to operate in an environment that is shared with people, the robot needs to be able to naturally interact with humans on an emotional level of perception. Sensory units allow the robot to find its area of operation and define its task space (Figure 2). It needs to be able to detect the proximity of people and give humans the possibility to operate it through an appropriate interface. The people being in the same environment with the robot, regardless if they passively or actively use the device, need to have the possibility to control the machine’s actions. In case of emergency, a mechanism to immediately secure the operation of the robot needs to be provided.

1.3. Development of Anthropomorphic Emotion Expression and Interaction Robots

In present research the advanced fundamental mechanical capabilities of anthropomorphic robots developed in Takanishi laboratory at Waseda University are to be enhanced in order to enable these robots to interact with humans in a natural way. In this paper we present two robots that have advanced capabilities to communicate with humans on an emotional level of perception. These robots have been developed over several years and present very recent advances in the field of emotional robotics and human robot interaction (HRI).
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