【論文の内容の要旨】

Human-robot interaction (HRI) is a broad multidisciplinary field that integrates artificial intelligence and human cognition in an attempt to sustain long-term relationship between human and robot. As robots become more advanced, it is expected that they will develop the capability of mutual reaction when they communicate with humans. To enable adaptive responses that are within a robot’s capabilities, it is essential to recognize a person’s internal state and establish user types for eliciting corresponding reactions from the robot. However, most HRI research has not given enough consideration to human cognition and interindividual differences. Furthermore, robot designs have been limited to produce generic expressions, which are insufficient considering the variety of humans and surroundings. To address these problems, this thesis proposes establishing user types which make the robot identify one’s personal features and eventually become capable of adapting to this particular type according to personal needs to improve the interaction. By sensing the person’s behavior, based on the uncovered type-corresponding mechanism explored in the study, the person’s perception of the robot can also be figured out which helps the robot’s reactions be fully understood by humans. In this thesis, human behavior includes verbal and nonverbal expressions. The user types are used as an indicator to provide the corresponding robot expressions. A field experiment revealed mutual influences between robot behavior and
the person’s internal state, indicating the importance of robot expressions that correspond to user type.

The focus of this thesis is twofold:
1) First, it presents the criteria for categorizing people with similar behavior into the same user type after taking interindividual differences into consideration. It is difficult to implement reactions for all possible situations due to the variance and complexities of human beings. Nevertheless, similar human experiences can yield similar behavior, making it possible to categorize people who behave similarly into the same user type. The human behavior is first recognized as one of the selected conditions, confidence or unconfidence. Then the similarities of the human behavior are analyzed to provide the basis for user types.

2) Next, it presents a method for robot expression design in which expressions corresponding to user types are designed by considering a person’s impression preferences in an attempt to increase the acceptability of the robot by the person. Prototypes of robot expression patterns are built on the basis of an understanding of human behavior. The prototypes demonstrate the capability of a robot to express internal states such as “cute” and “cool.” The interindividual differences from the aspect of the human internal state are then discussed. The user’s impression preferences for the prototype robot expression patterns reveals the importance of user types for eliciting corresponding robot expressions. The basic parameters for the robot expressions are selected from the robot prototype expression patterns using the user’s impression preferences. Finally, the mutual influences between robot behavior and human internal state are demonstrated to stress the importance of user types in HRI.

This thesis comprises five chapters:

Chapter 1 describes the background and motivation as well as the overall structure of this thesis.

Chapter 2 describes the concept of user type from the aspect of bidirectional interactions between humans and robots. To form the basis for user type, the robot’s recognition of the person’s behavior and the person’s respective perception of the robot’s expressions are considered. The utilizations of human behavior recognition and human perception sensitivity are explained. The process of designing basic robot expressions using user impression preferences is described. In addition, the development of robot responses that correspond to user types is explained. Relevant literature on human behavior sensing, human cognition, and robot impression evaluation is reviewed to support the motivation for this thesis.

Chapter 3 states the process of identifying the selected human internal state,
confidence. Both the verbal and nonverbal features of human behavior are obtained to recognize the conditions confidence and unconfidence. Subsequently, the human behavior similarities are analyzed to provide the basis for user type.

Chapter 4 focuses on robot expression design. On the basis of human behavior understanding, a “cute” style and a “cool” style are selected as target characteristics for robot expressions. User preferences for the cute and cool styles are used to establish the basic parameters for each expression style. A field experiment showed the significance of constructing robot expressions that correspond to user types in HRI.

Chapter 5 draws several conclusions and then presents potential applications and prospects of further development.