

Title	ソーシャルロボットの非言語的行動生成に向けた人との長期相互作用による増分学習
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Citation	
Issue Date	2021-03
Type	Thesis or Dissertation
Text version	ETD
URL	http://hdl.handle.net/10119/17473
Rights	
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Incremental Learning from Humans through Long-term Interaction toward Generating Non-verbal Behavior of Social Robots

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People use a wide range of non-verbal channels, including facial and bodily expressions, to communicate their emotions or intention during human-human interaction. Those modalities encourage the communicators' messages could be transmitted to interacting partners in a facile and transparent manner. Being echoed by the influence of human social behaviors, recent studies in human-robot interaction have investigated how to generate non-verbal behaviors for social robots in a way that is appealing and familiar to human partners.

However, non-verbal behaviors are ambiguous. The way how humans express and interpret social behaviors is highly affected by many different factors, including individual personality, cultural background, and other environmental settings. To tackle this problem, the study presented in this dissertation focuses on developing robots' social gestures to adapt to interacting partner's behaviors, allowing generated robots' gestures are familiar to the current social norm. The proposed approach concentrates on the body channel for expressing robots' emotional states and supporting semantic contents of robots' speech. To achieve that, we design the model for generating emotional gestures, the model for generating communicative gestures, and the transformation model. The suggested frameworks endow a robot with capabilities of learning from human behaviors obtained through long-term interaction and transforming generated gestures into the robot's motion, being the robot's social cues supporting for different interaction contexts. We demonstrated the proposed idea on a target social robot. A series of experiments was conducted to evaluate the designed frameworks considering the human perception of generated robot's social cues and the quality of generated gestures. The experimental results also confirmed that different users may interpret the same robot's gesture in different ways. Therefore, the problem of behavior adaption should be addressed when designing non-verbal cues for social robots.

Keywords: *social robots, human-robot interaction, non-verbal behaviors, emotional gestures, communicative gestures, imitation learning.*