Mechanical Engineering Doctoral Defense

Modeling human adaptation with game-theoretic intent decoding in Human-Robot Interactions

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Abstract

Human-Robot Interaction (HRI) has become ubiquitous in applications such as autonomous driving, robot-assistive rehabilitation, robotic surgery, and collaborative manufacturing. In these applications, an intelligent robot needs to build a human model (often referred to as theory of mind) to anticipate human actions for proactive planning of its own actions, similar to the collaboration strategy between human agents. A comprehensive human model urges the capability of capturing human nature such as rationality, randomness and even social-awareness. In order to simulate human's behavior, estimating human intent, which is the abstraction of the inherent physical or psychological factors that affect a human's actions, has been adopted to encapsulate the diversity of individuals. Human subjects' tests have been conducted to find a relationship between the psychological construct of trust and joint physical coordination. We define compliance and reliance in the context of physical HRI to characterize human responses in a joint object transport task. Game theory provides a mathematical aspect of constructing human's rational decision-making process, which provides a baseline behavior to help us construct more sophisticated human models. By studying human-human dyadic actions, we adopt the bounded rationality theory of Oretga (2016) upon a game-theoretic model to capture the rationality behind the randomness of human subjects. Further, the mutual intent inference and strategic motion planning methods, which are built upon a game-theoretic interaction model, are practiced to generate human-like social-aware driving behavior in an autonomous driving scenario. The empathetic effect, which serves as an inherent human nature, has been suggested to be a fatal factor that causes the complexity of human behavior. Human subject experiment and model simulation proposition its existence during conventional HRI scenarios.

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