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Control and Adaptation with Provable Safety and Resilience Inspired from the Human Sensorimotor System

研究成果の概要

We developed stochastic safe control techniques for uncertain systems with changing parameters and information-sharing constraints. With stochastic uncertainties with unbounded support, a myopic controller that ensures safe probability in infinitesimal time intervals may allow the accumulation of unsafe probability over time and result in a small long-term safe probability. Meanwhile, increasing the outlook time horizon may lead to significant computation burdens and delayed reactions, which also compromises safety.

To address this, we introduce a new notion of forward invariance on probability space that can be used to assure long-term safety using myopic controllers (1). The proposed technique was then generalized and applied to multi-agent systems with information-sharing constraints (2), autonomous vehicles operating in slippery environments (3), and systems in highly occluded environments (4). The method was validated using numerical and onboard experiments. The proposed method systematically mediates behaviors based on uncertainties and other agents' interaction models, finds safer actions even with large uncertainties, and has the transparency in the exposed risks.

Consequently, the proposed method has better safety vs. performance tradeoffs and graceful performance degradation than the existing methods. Finally, we also studied how to make safe decisions in the presence of strategic human behaviors (5).

【代表的な原著論文情報】

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