Bio-inspired Learning for Enhanced Control of Soft-Robot Arms in Nonlinear Systems

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This talk explores the integration of a bio-inspired learning module with nonlinear model-based control systems in soft robotics. Traditional control methods rely heavily on precise, often rigid models to predict and manage the complex dynamics of soft robots. However, these models can struggle with the inherent unpredictability and variability of soft material-based robotics. By incorporating a model-free learning component into the control architecture, our approach offers a dynamic solution that adapts in real-time to the robot's behavior. Drawing on principles of feedback-error learning, the learning module enhances the robot's ability to follow desired trajectories by learning from the discrepancies between expected and actual movements. This bio-inspired strategy not only compensates for the non-linearities and uncertainties inherent in soft robotics but also simplifies the control mechanism through adaptive learning. The efficacy of this method is demonstrated by comparing it with a conventional control setup, which lacks the adaptive learning feature and relies on a predefined model of robot dynamics. Our findings highlight the advantages of incorporating learning for improving the performance and flexibility of soft robotic systems, potentially surpassing traditional control methodologies in terms of adaptability and efficiency.