

Propositions

accompanying the dissertation

SAFE YET PRECISE SOFT ROBOTS

INCORPORATING PHYSICS INTO LEARNED MODELS FOR CONTROL

by

Maximilian STÖLZLE

1. Integrating physical priors into learned dynamical models enables computationally efficient, provably stable control while also enhancing model expressiveness through data-driven learning. [Core Contribution]
2. A key limitation in the soft robotic literature is that the tradeoff between performance and safety remains insufficiently quantified and exploited. [Chapter 3]
3. Substantial progress in soft robot proprioception can be achieved by optimizing the hardware and software integration of established commercial sensing modalities—such as cameras or IMUs—instead of relying on novel, yet unproven, technologies. [Chapter 4]
4. We need to strive for compliance in both body and brain when operating robots close to humans. [Chapter 7]
5. A primary barrier to advancing soft robotics research is the absence of integrated benchmarks and baselines.
6. Simply increasing the quantity and diversity of data is not enough to develop effective, robust robot models and motion policies unless we also integrate physical structure and stability guarantees.
7. Although motion policies jointly learned across different robots can improve generalization, specialized policies for each robot are essential to fully exploit its characteristics and maximize performance on highly dynamic tasks.
8. Universities expanding non-managerial career paths solely dedicated to research would enhance research quality and its societal impact.
9. Restructuring large tech companies as worker cooperatives would promote balanced decision-making, enhance inclusivity, and reduce societal division.
10. Unless international treaties that establish guidelines and guardrails for deploying robots and AI are implemented within this decade, the societal drawbacks of robotics are likely to outweigh its benefits.

These propositions are regarded as opposable and defensible and have been approved as such by the promotor Prof. Dr. R. Babuška and the copromotor Dr. C. Della Santina.