Discrete Variable Stiffness Actuators with Fast Stiffness Switch for Safe Human-Robot Interaction

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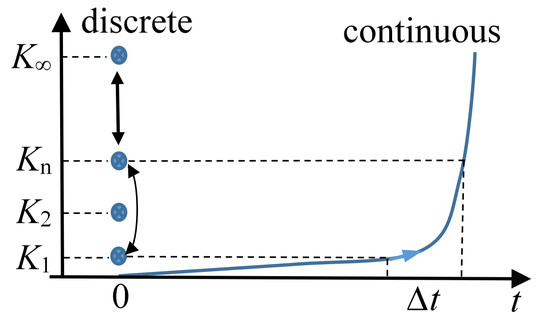
This project aims to fill the fundamental research gap in compliant robot actuation by proposing a new concept of discrete variable stiffness actuators (DVSAs) and developing a systematic design methodology with high-performance control algorithms, validated by experimental tests.

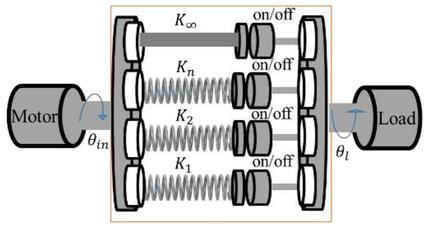
Research Problem

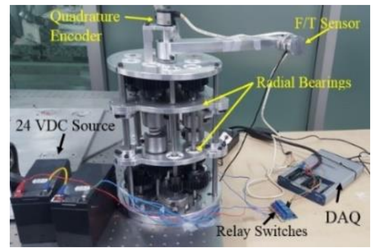
A fundamental challenge for the development of co-robots has been finding a balance between high performance and high safety for human interaction, which requires variable stiffness. Existing concepts largely focus on continuous stiffness change resulting in complex designs, high-energy consumption, non-real-time stiffness change, and non-ideal stiffness profile.

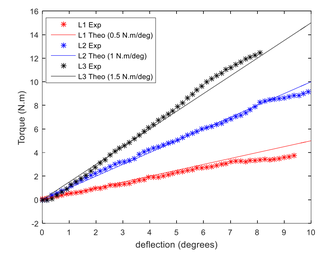


Intellectual Merit

1) Design representative stiffness levels through discrete principles with consideration of safety of both human and robot.
2) Develop advanced adaptive control algorithms to cover the switching dynamics of the new actuators.

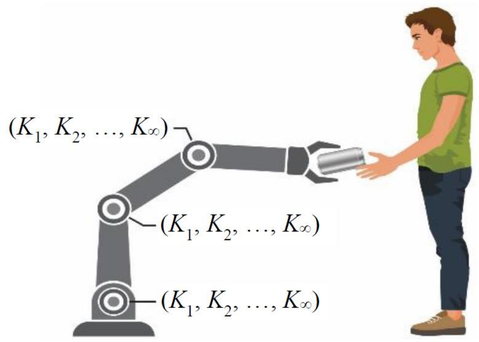






Broader Impacts - society

The research enables new generation of co-robots for safe human-robot co-working in industrial manufacturing. Co-robots will protect workers and leverage their work safety and efficiency. The intrinsic safety will reduce injuries and disability cost in the workplace.



Scientific Impact

The DVSA concept will not only advance VSA-robot development, but also offer a new roadmap for developing compliant actuators benefiting the robotics industry with adaptable compliant dynamics enabled by variable stiffness on walking robots, entertainment, medical and education robotics with human robot physical interactions and needs of intrinsic safety.

Broader Impacts - education

- Expose undergraduate with research experience through the developed actuator platforms and capstone project design
- K-12 students engagement through summer camps
- STEM workshops for Purdue Polytechnic High Schools (Nearly 70% of the student body is black) through the Indiana Manufacturing Competitiveness Center (IN-MAC)