IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Higher Order Sliding Mode Control

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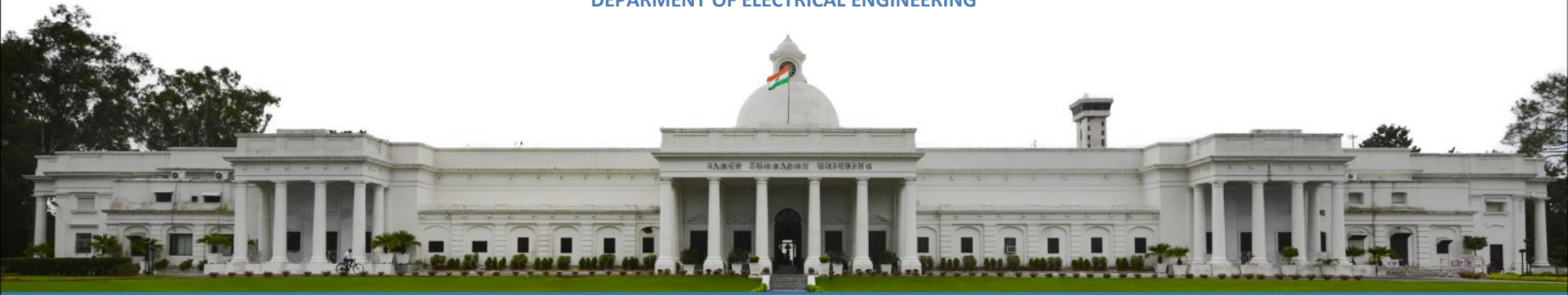
DEPARMENT OF ELECTRICAL ENGINEERING



Higher Order Sliding Mode Control

Outline

1. Introduction

2. Higher Order Sliding Mode Control

3. Simulation Study on Percutaneous Interventions using bevel-tip needle

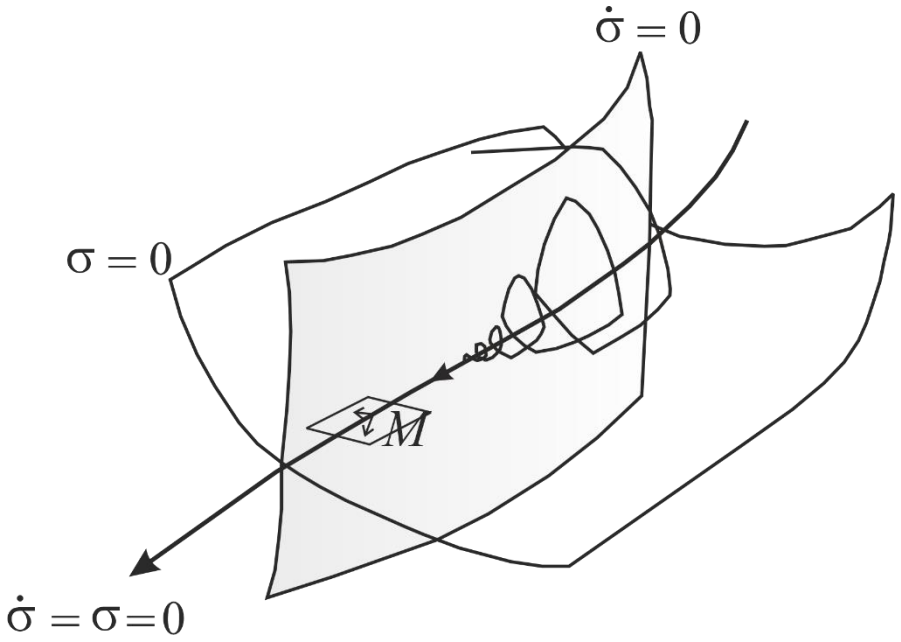
4. Conclusion

Introduction

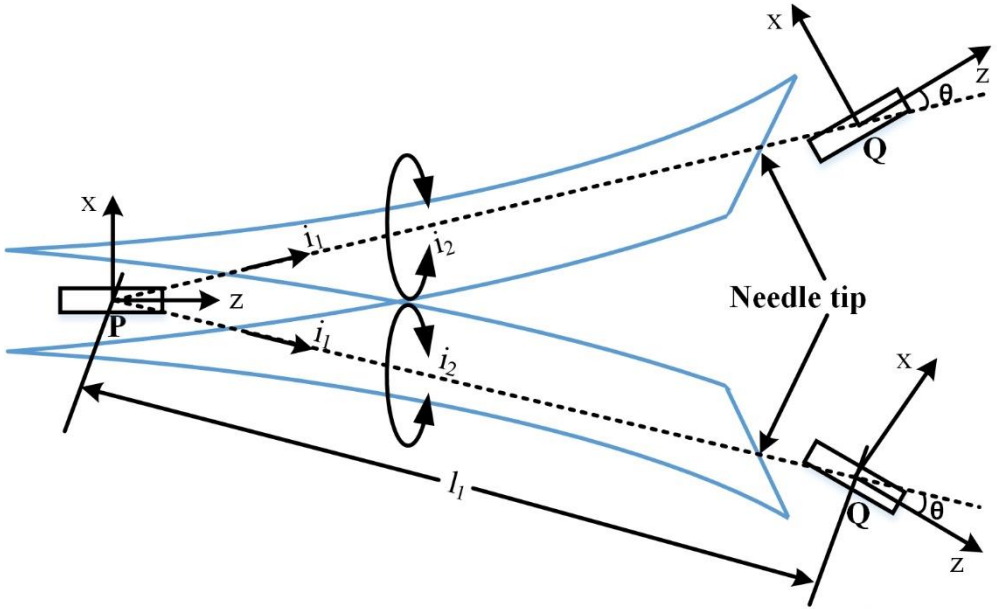
- SMC has several properties – robustness, parameter variations, reduced order dynamics
- Higher order SMC retain most of the properties and is a generalization of idea of 1st order SMC
- Higher order derivative is acted on the sliding variable instead of influencing 1st derivative

i.e., $\ddot{\sigma} = f(u)$

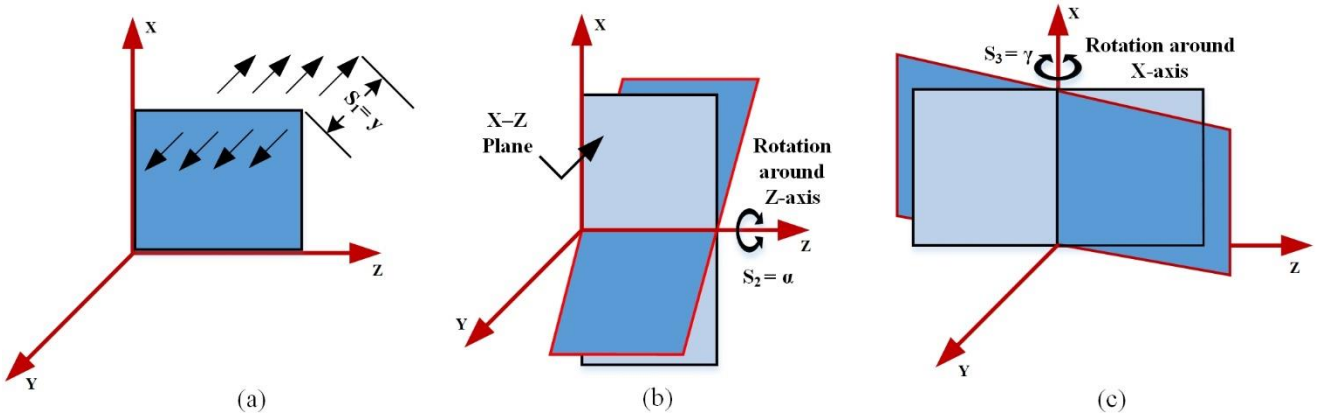
Introduction (cont'd)



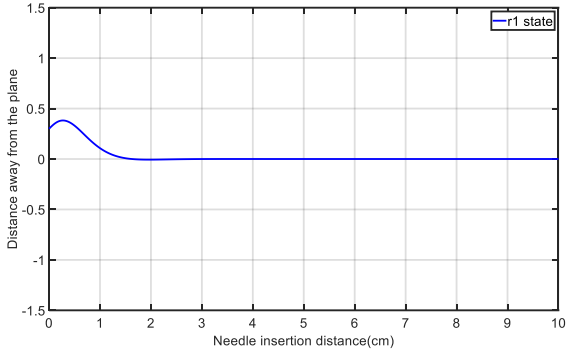
Simulation Study on Percutaneous Interventions using Bevel-Tip Needle

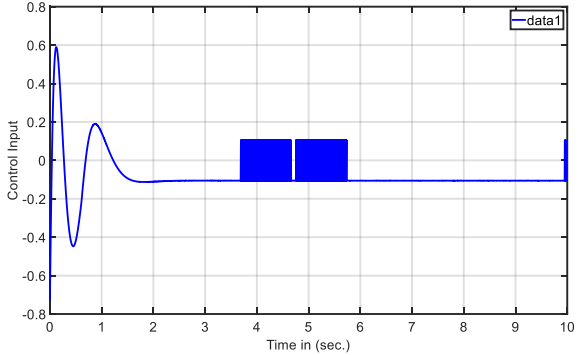


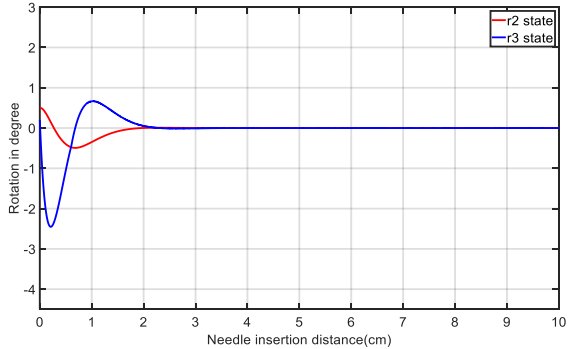
System States

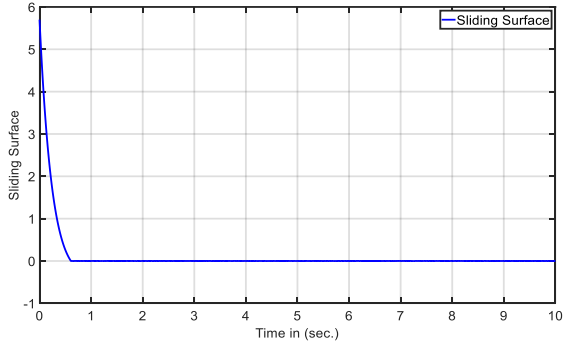


Conventional SMC Strategy



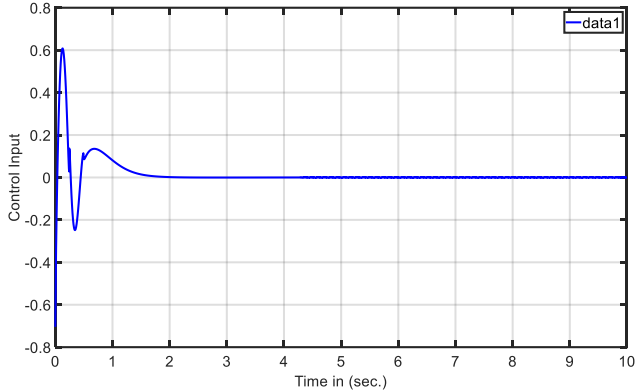


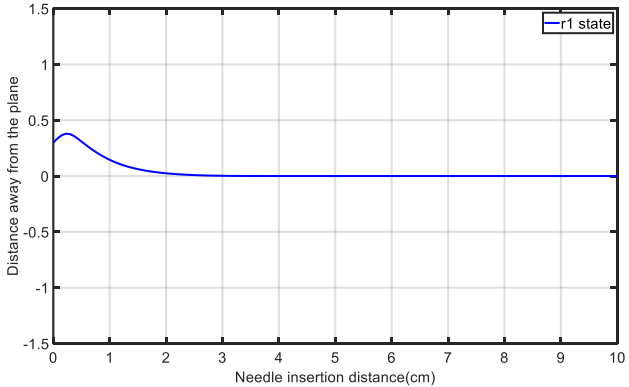


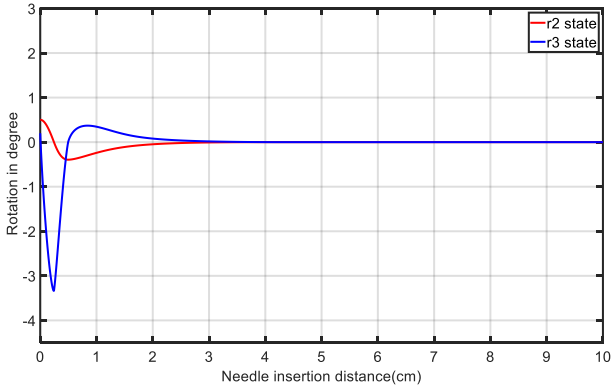


Evolution of states, sliding surface and control input with conventional SMC strategy.

Conventional SMC Strategy

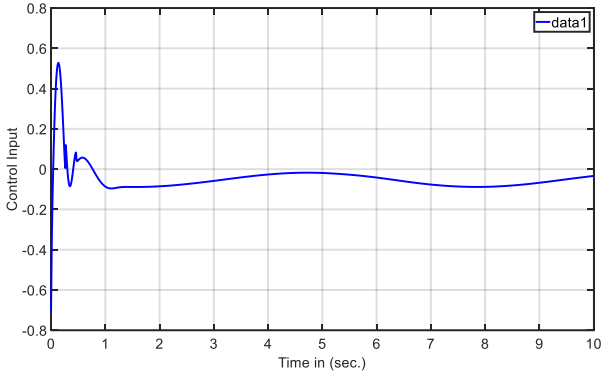


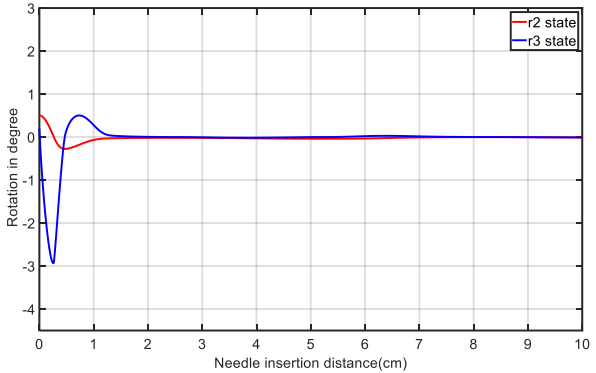


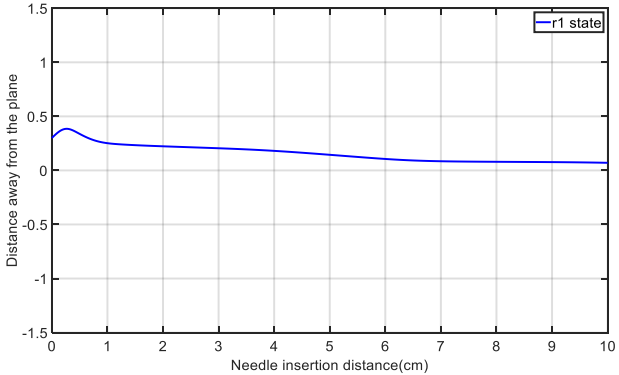


States and control input in the *absence of disturbance*.

Conventional SMC Strategy

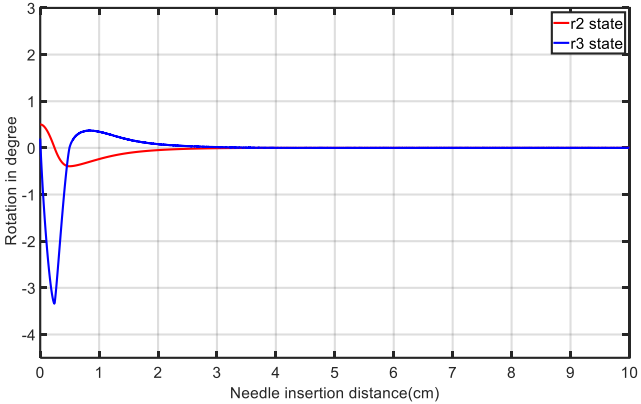


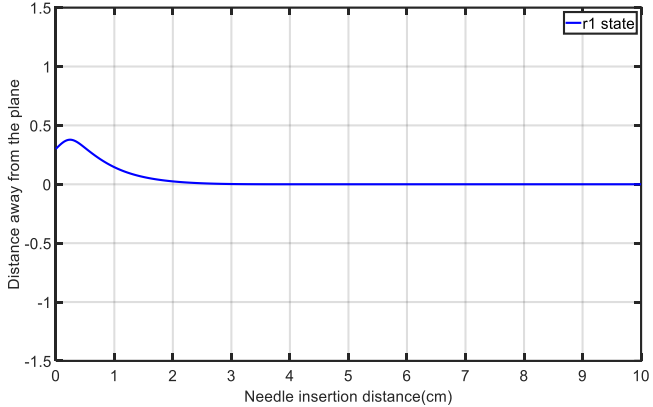


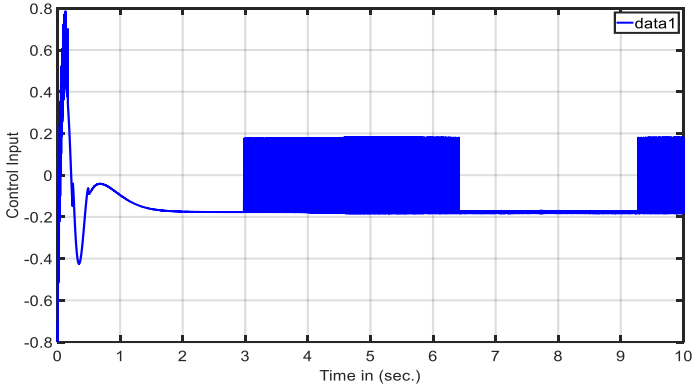


Evolution of states and control input in the presence of disturbance with nominal control.

ISMC Strategy with discontinuous control

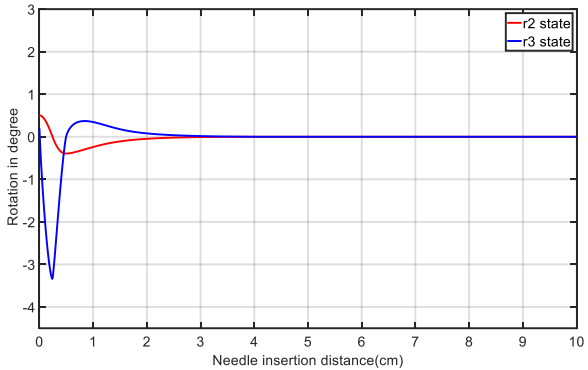


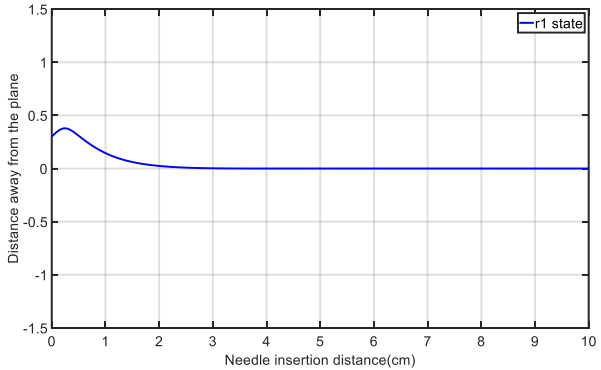


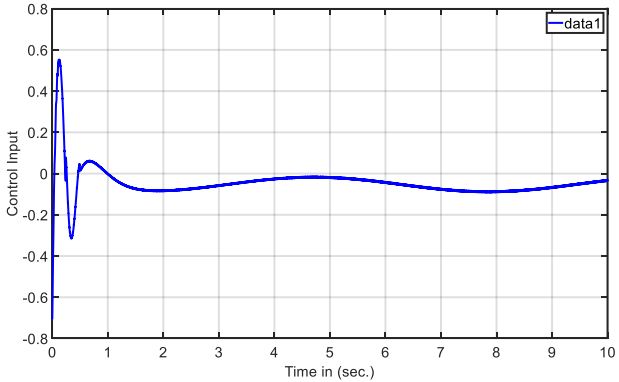


Evolution of states and control input of ISMC with discontinuous control.

ISMC Strategy with STC

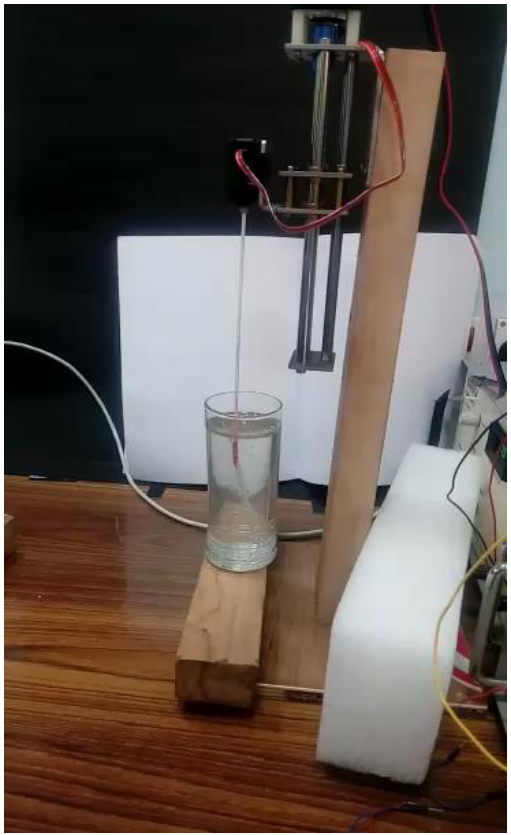






Control input in the presence of disturbance with ISMC based on STC.

Experimentation: ISMC Strategy with STC



Conclusion

- Higher order SMC confirms finite time convergence of the system states.
- Proof of distance and time convergences.
- Robust Control of Percutaneous Needling System.
- ISMC with STC → better performance.

Thank You!