Realizing a highly compliant remote-operated robot

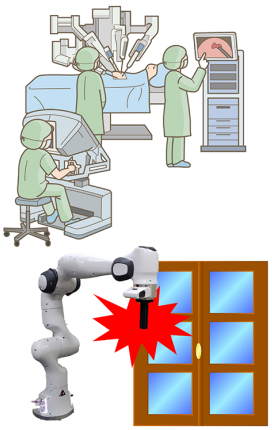
How should we interact softly from afar?

Abstract

Teleoperation, the technology of controlling robots from a distance, is useful for remote medicine and for working in inaccessible or hazardous environments. These remote-operated robots need to move accurately and interact safely or compliantly with their surroundings. Conventional remote-operated robots have trouble accurately following or tracking the movements of a human operator whilst moving compliantly, especially in the presence of communication delays. By predicting the operator's movement intention based on a model of their movement characteristics, we developed a method to control a remote-operated robot accurately and compliantly in the presence of communication delays. Our technology enables intuitive control of remote robots that safely interact with their environment. We hope it will contribute towards the creation of safe space sharing between humans and robots, and to the development of robots that physically care for and interact with people.

Controlling a remote robot from afar

- Remote-operated robots are useful for working in remote or hazardous environments.
- Effective remote operation demands a robot that moves accurately and compliantly.
- A robot with insufficient compliance can damage its surroundings.

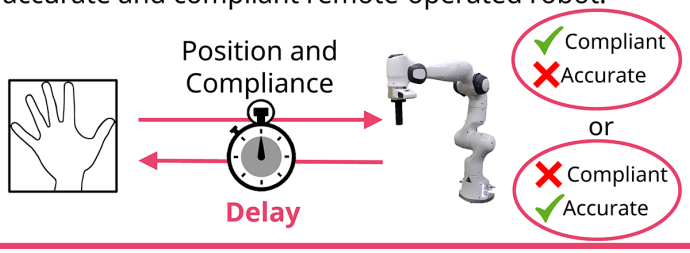


How to move robots compliantly

Communication delays between the operator and the robot produce a positive feedback loop that makes it difficult to move a robot both accurately and compliantly.

Existing method (Teleimpedance)

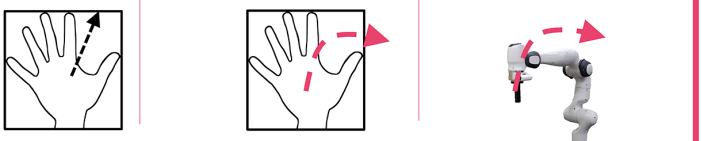
While Teleimpedance can make the remote robot somewhat compliant, adding further compliance comes at the cost of poor tracking accuracy. With this existing method it is difficult to realize a highly accurate and compliant remote-operated robot.



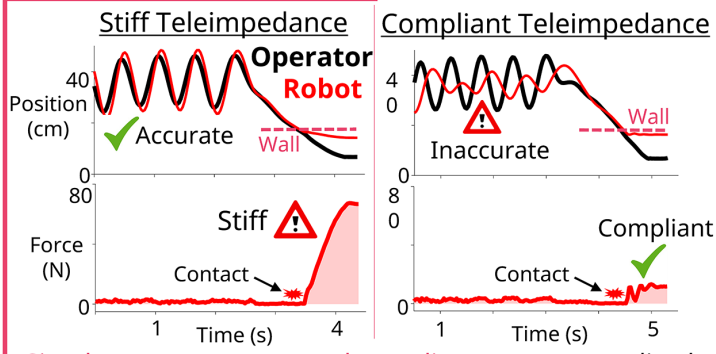
Accurate and compliant remote robot

By predicting the operator's movement intention, we developed a remote robot that moves precisely and compliantly despite communication delays.

1. Operator moves.
2. Use model[1] to get movement intention.
3. Robot tracks movement intention.

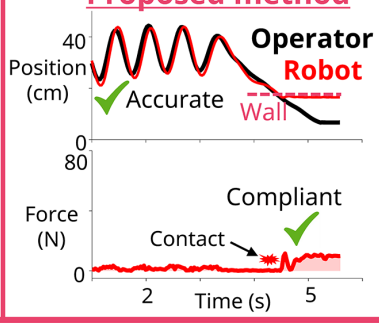


Experimental results



Simultaneous accuracy and compliance was not realized.

Proposed method



Despite being as compliant as the existing method, ours improved tracking accuracy by 74%, thereby increasing the effectiveness of remotely operated robots.

References

[1] A. Takagi, Y. Li, E. Burdet, "Flexible assimilation of human's target for versatile human-robot physical interaction," *IEEE Transactions on Haptics*, Vol. 14, No. 2, pp. 421-431, 2020.

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