# Robot Movement Control Using Force Sensor in Remote Robot Systems

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# Outline

- **Background**
- **Previous Work**
- **Remote Robot Systems with Force Feedback**
- **Purpose of This Work**
- **Experiment Method**
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- **Conclusion and Future Work**

# Background

**Remote robot systems with force feedback**

*A user can remotely operate a robot having a force sensor by using a haptic interface device while monitoring the movement of the robot.*

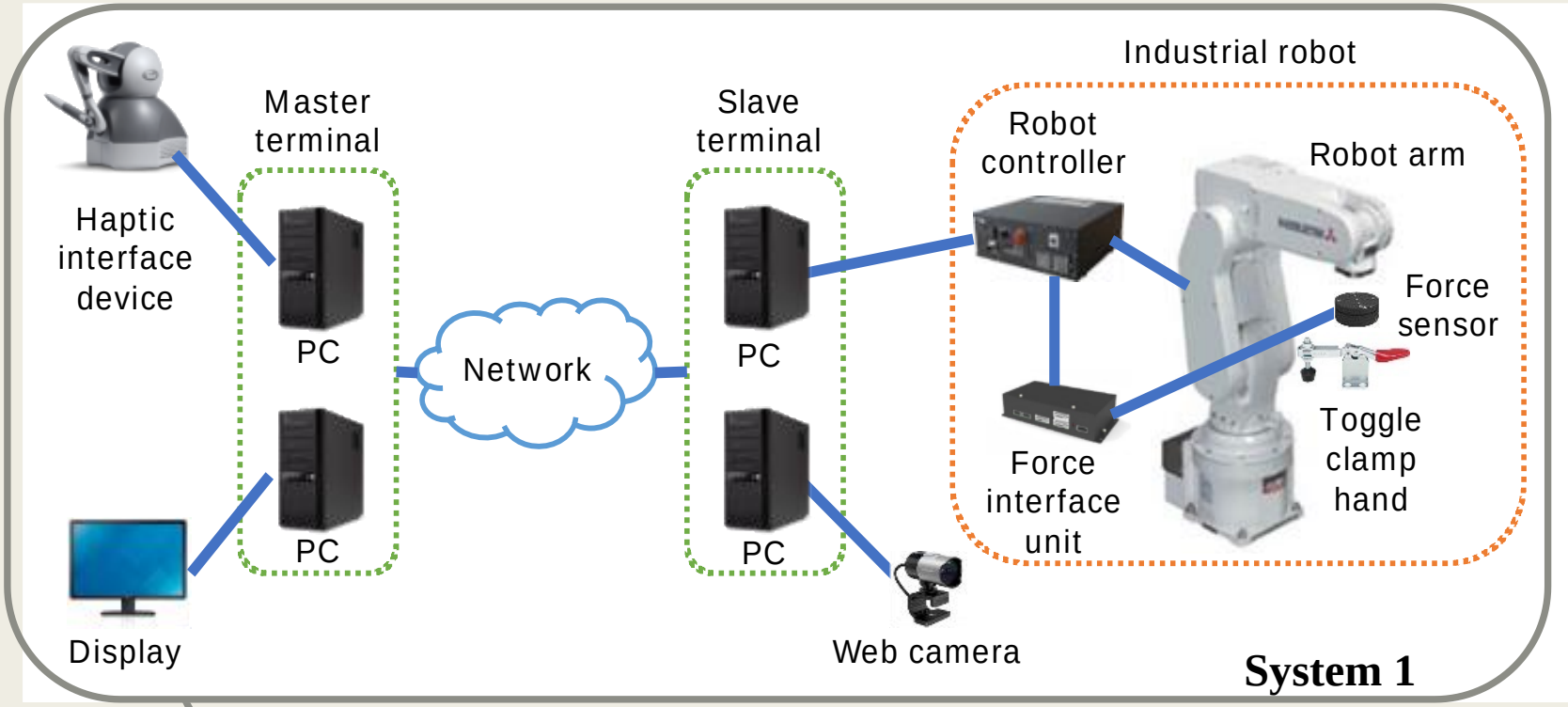
⇨ **Efficient and accurate cooperative work between the systems**

Feel the force obtained by the force sensor when the robot touches/moves an object

**Network environments are not always good.**

⇨ Cooperative work between the systems without communication

# Remote Robot Systems with Force Feedback



*1 S. Ito *et al*., ICIET, Mar. 2021.
*2 S. Ishikawa *et al*., IEICE CQ2020-18, June 2020.

# Previous Work[*1]

- Carrying an object between two remote robot systems
- Suppose that the network environment of one system becomes worse
- By using force information obtained by the force sensor, a robot of the system follows the movement of the other robot.
- **Enhancement of the robot position control using force information[*2]**

$$\boldsymbol{P}_t = K_{\text{adj}}\,\boldsymbol{F}_t$$

$\boldsymbol{P}_t$ : Position adjustment vector, $K_{\text{adj}}$ : Coefficient (depending on velocity)

$\boldsymbol{F}_t$ : Sensed force

- **Comparison between a robot under the enhanced control and a human**

⇨
- Possible to move the robot under the control without communication
- **The human outperforms the robot, which applies larger force to the object.**

# Purpose of This Work

- Propose robot movement control using force sensor
- Compare the effect of the proposed control by experiment

**This Work**

**Robot movement control using force sensor**

$$\boldsymbol{P}_t = \alpha\, \boldsymbol{P}_{t-1} + K_{\mathrm{mov}}\, \boldsymbol{F}_t \qquad (0 \leq \alpha \leq 1)$$

$\boldsymbol{P}_t$ : Position adjustment vector, $K_{\mathrm{mov}}$ : Coefficient (depending on weight of object)(=0.279[*3]), $\boldsymbol{F}_t$ : Sensed force

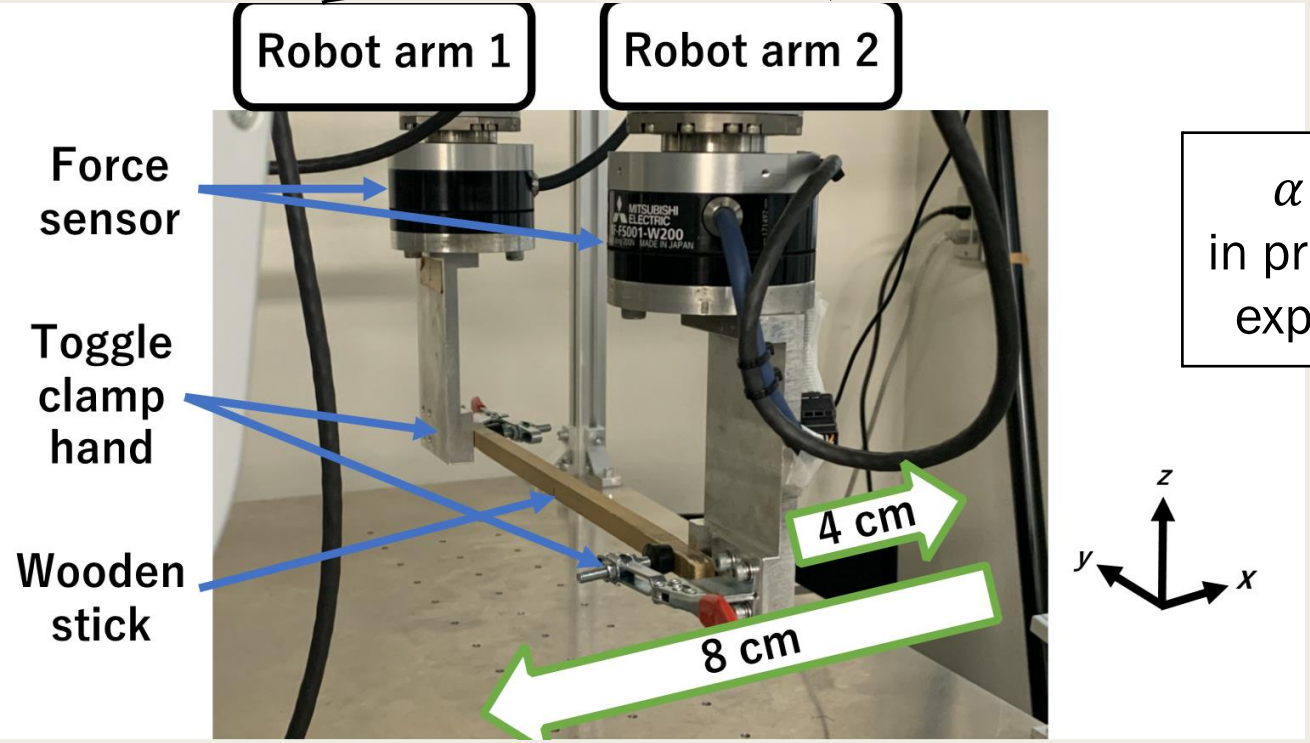
**Based on Newton's equation of motion and the formula about distance and time**

*3 S. Ishikawa *et al*., WSCE, Dec. 2019.

# Experiment Method

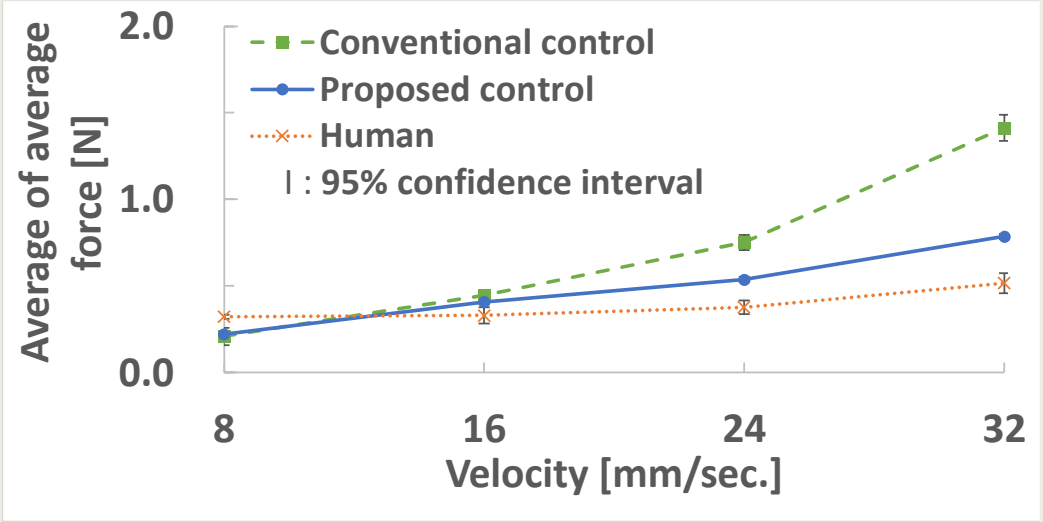
Followed the movement of robot arm 1 under the control

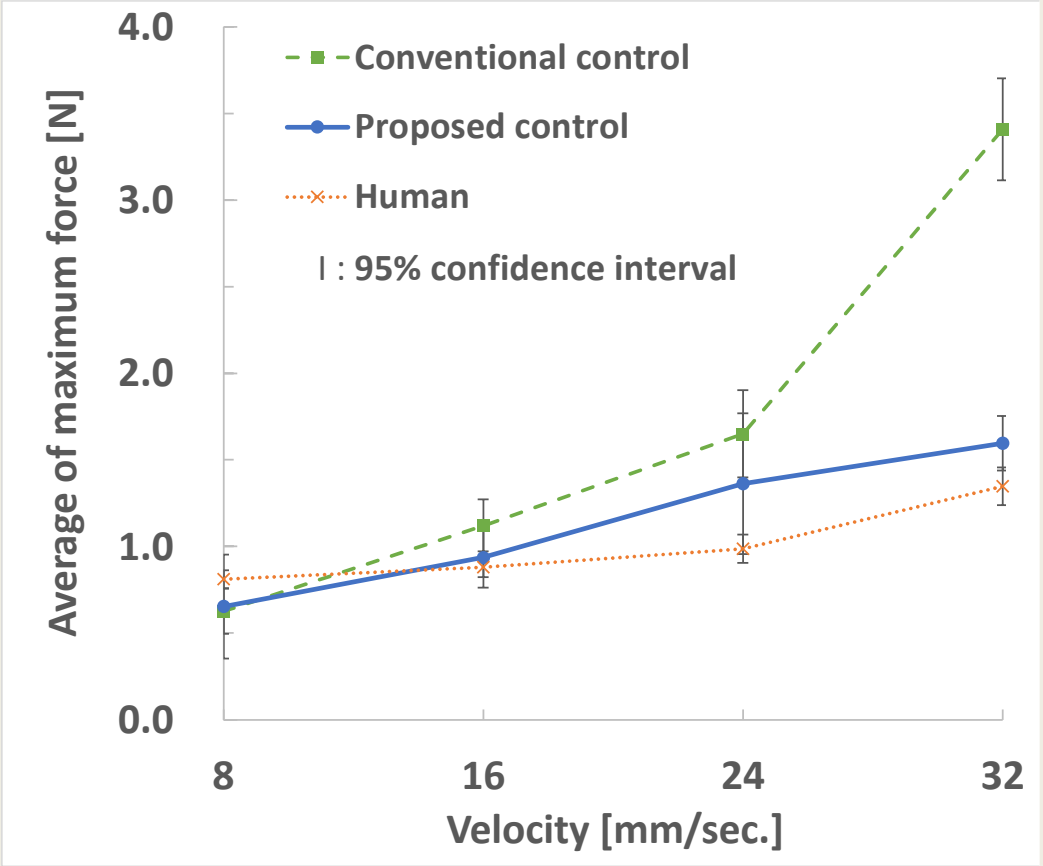
Moved automatically




$\alpha = 0.9$ in preliminary experiment

# Experimental Results



# Conclusion

- Proposed the robot movement control using force sensor for cooperative work between two remote robot systems with force feedback
- Examined the effect of the proposed control by experiment

⇨
- **The proposed control is superior to the conventional control.**
- **We need to further improve the proposed control.**

# Future Work

- Clarification of the optimal values of parameters ($\alpha$ and $K_{\mathrm{mov}}$)
- Study of switching method between the proposed control and control in which communication between two robots is possible