# HAJI Reading Notes

## Backgrounds

- Classic Paradigm Challenges:
    1. **Persistent Error** significantly degrade the teleoperation
    2. **Discrepancies** between the structures of human hands and robot end-effectors
    3. **The Lack of Haptic Feedback** during contact-rich manipulation (Haptic: 触觉)
- So, need human efforts and high-quality datasets.

## Intro

*In data-collection, how to make human effort less while improving the data quality?*

**HAJI**:

1. Preferentially capture `intentions`.
2. Agent to ensure `motion stability` and `interpolate`? the details.
3. Shared control(with a growing ratio).

Acchived a 30% increase in data collection success rate and double the `collection speed`.

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My question about this part: how to define and measure the collection speed?
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## Method

### In Brief

**Stage1**: Human control as an initial but insufficient training dataset.

**Stage2**: Train a diffusion-model-based assistive agent, establish shared control.

Growing with more data coming in and if sufficient able to full auto.

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How diffusion be used to control a robot? What the outputs of this model be like?

Answer(from below parts): generate the action for agents
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### Preliminary

**DDPM**

1. **Forward**: Adding Guassian noise to $x^0$ according to $\beta *{1:K}$ by $x_k = \sqrt{\alpha_k}x{k-1} + \sqrt{1-\alpha_k}\varepsilon$, $\varepsilon \sim \mathcal{N}(\textbf{0, I})$, $\alpha _k = 1 - \beta _k$

2. **Reverse Process**: $p_\theta(x^0)=\int p(x^K)\prod p_\theta(x^{k-1}|x^k)dx^{1:k}$, where $p_\theta(x^{k-1}|x^k)=\mathcal{N}(\mu _\theta(x^k, k), \sum(x^k, k))$.
3. **Loss Func**: $\mathcal{L}:=\mathbb{E}*{k,x_0,\varepsilon\sim\mathcal{N}(\textbf{0,I})}[||\varepsilon-\varepsilon\theta(x_k(x_0,\varepsilon),k)||^2_2]$.
4. **Generate $x_0$**: $x_{k-1}=\mu _\theta(x_k, k) + \sigma_k z$, $z \sim \mathcal{N}(\textbf{0,I})$ (sampled recursively).
5. With collected trajaectory ${(s_i,a_i)}^T_{i=0}$, $\mathcal{L}:=\mathbb{E}*{k, (s_i,a_i),\varepsilon\sim\mathcal{N}(\textbf{0,I})}[||\varepsilon-\varepsilon\theta(a_i+\varepsilon,s_i,k)||^2_2]$.

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Q: What is x_k(x_0,\varepsilon)?
A: A function to get x_k from x_0 with \varepsilon?
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## Teleoperation System

We can get the human collected demonstration ${(s_i,a_i)}^T_{i=0}$, $s \in \mathbb{R}^n$ is the robot state.

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Q: What state exactly?
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## Diffusion-Model-Based Assistive Agent