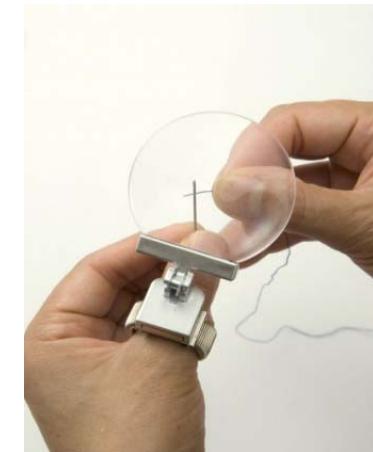
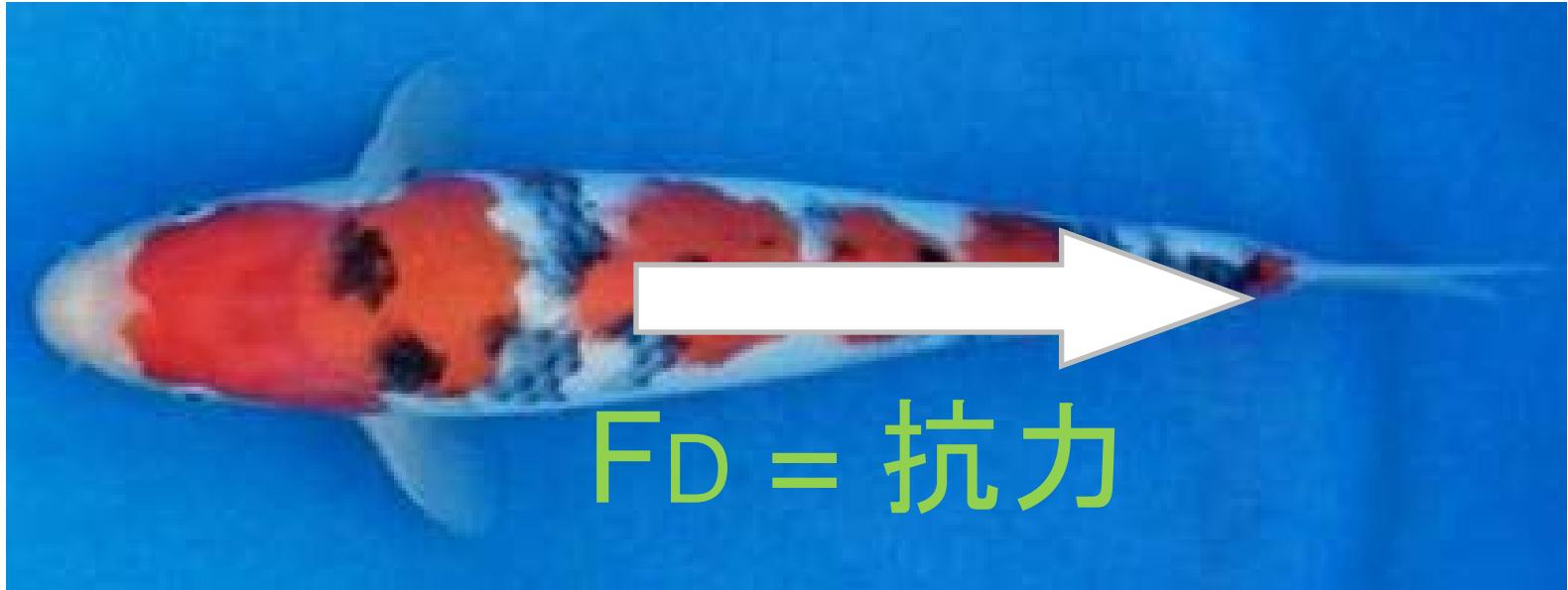


機構学

Part7: バイオミメティック アプローチの盲点

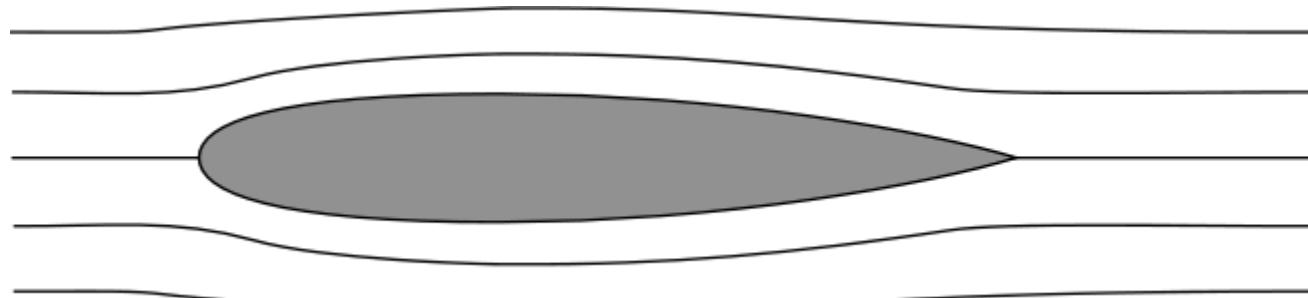


魚

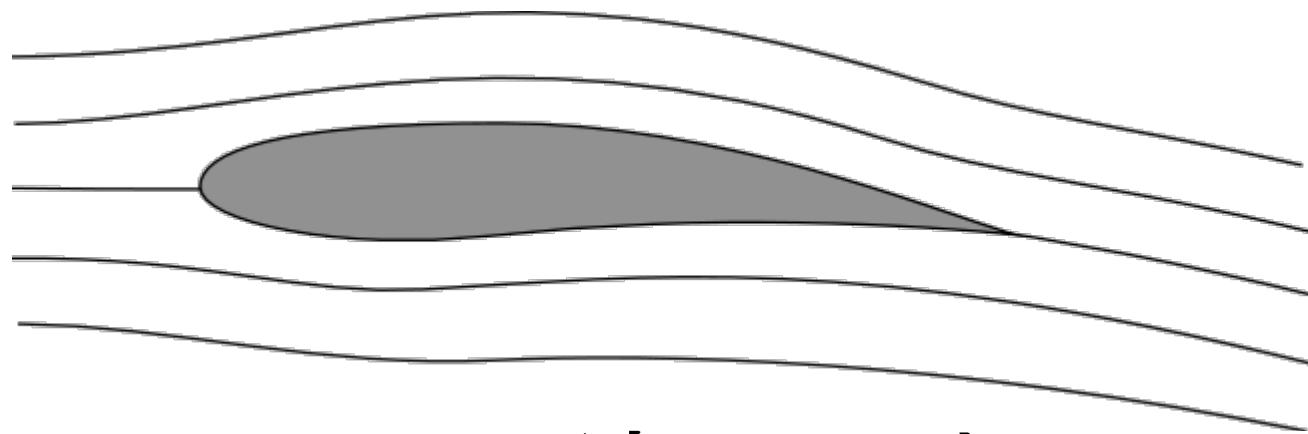


F_D = 抗力

魚の形状を真似た翼設計



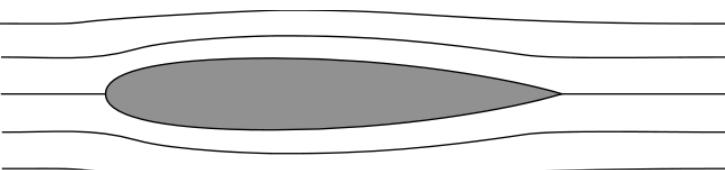
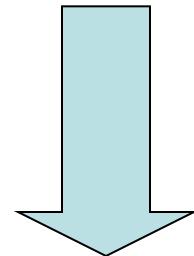
イミテーション



最適翼設計

バイオミメティックアプローチ

生物



完全イミテーション

鳥



バイオミメティックaproach

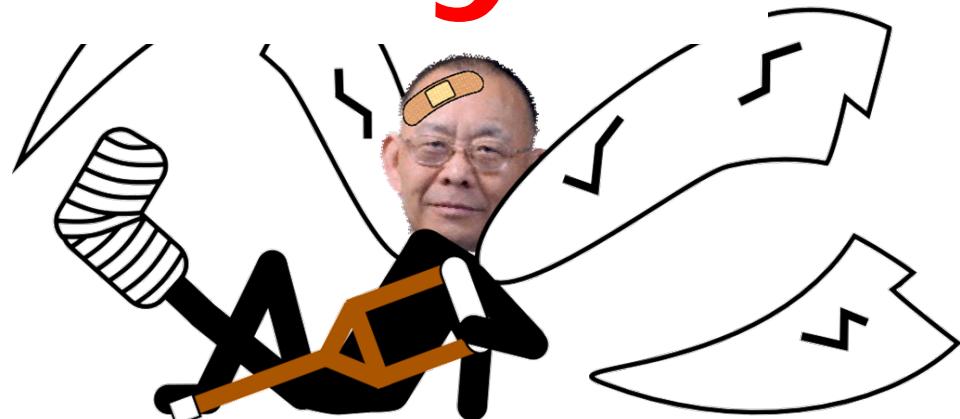


Leonardo da Vinci

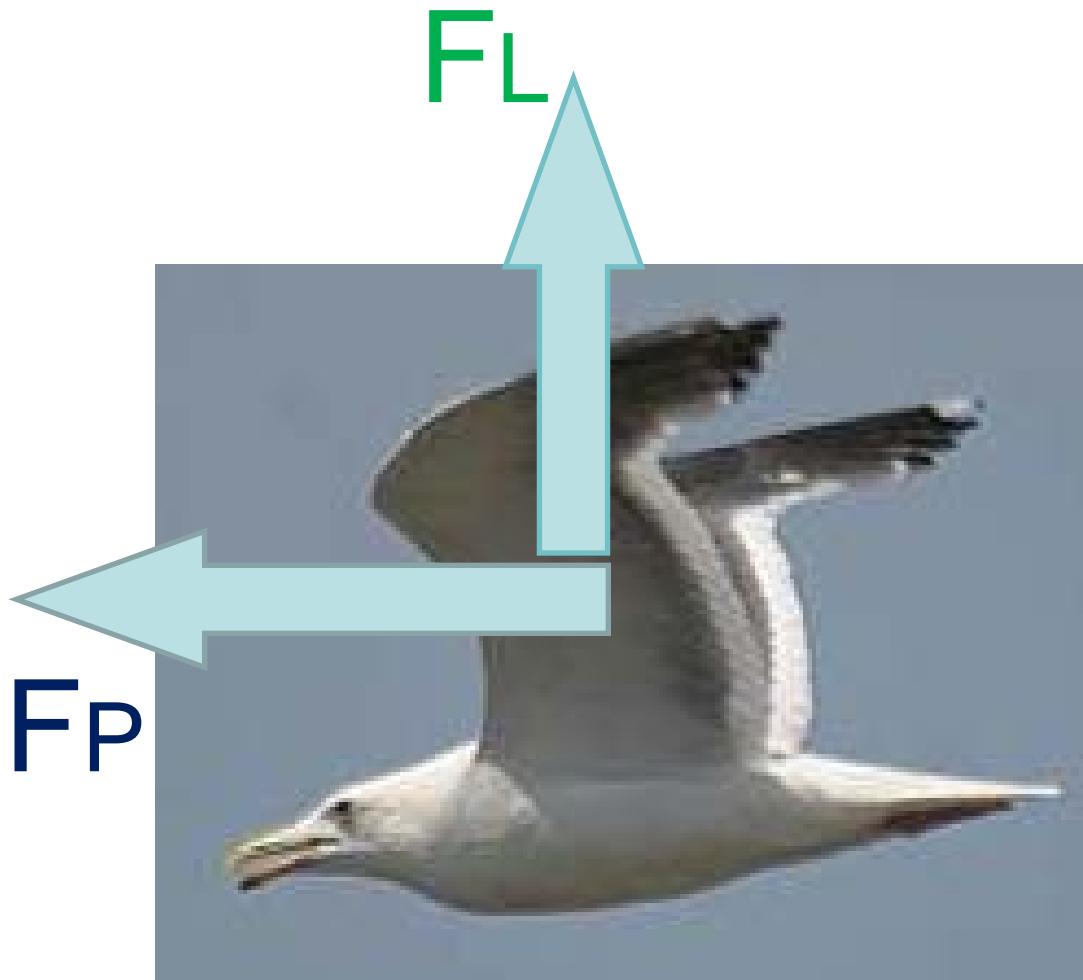


鳥を真似ると…

Why?

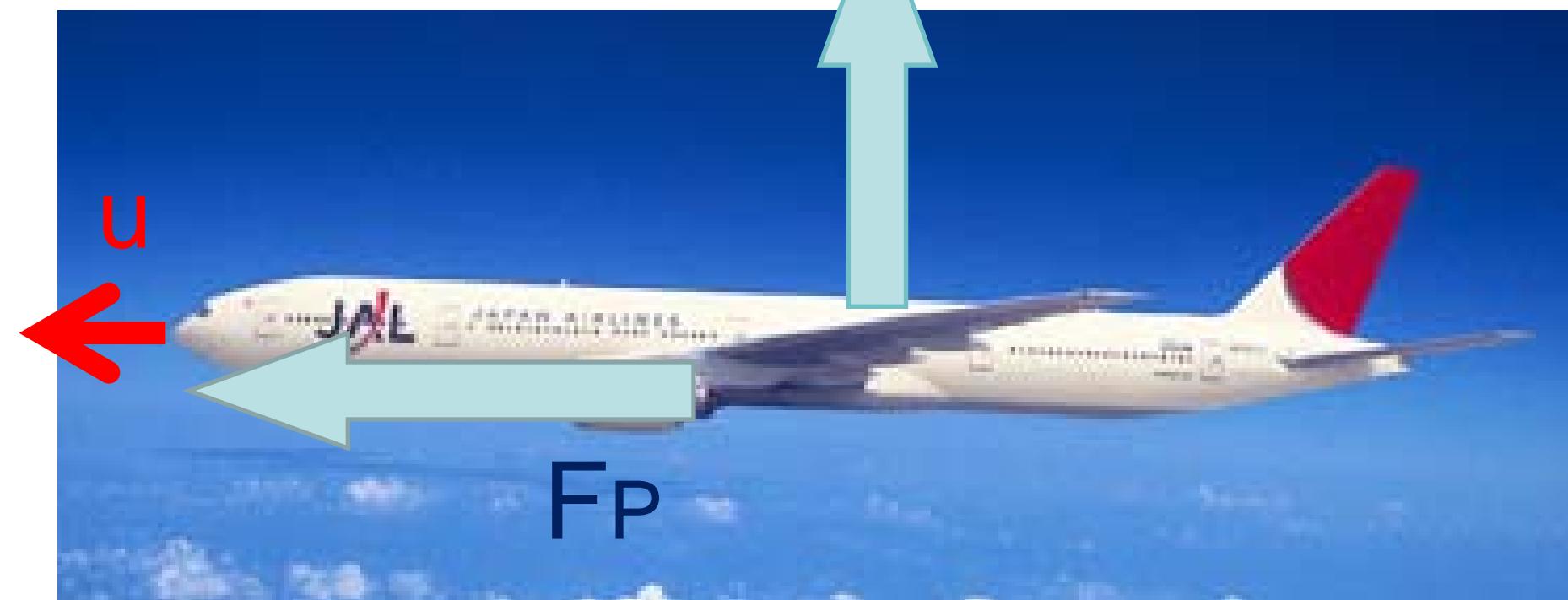


鳥から飛ぶ機能を抽出・・・



鳥から飛行機への飛躍

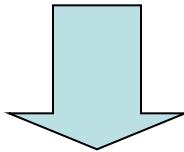
$$F_L \propto u^2$$



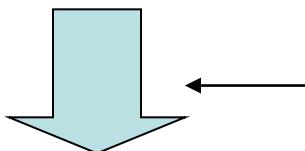
バイオミメティックアプローチ



生物



機能抽出



設計 (アイデア)

人工機械

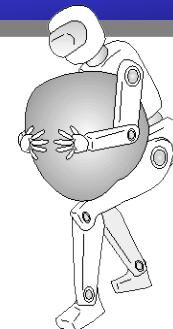
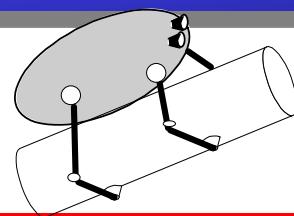
かもめモデル



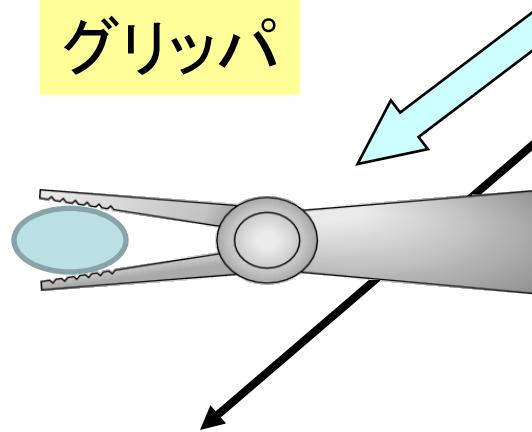
Festo Robotic Seagull

把握と操り

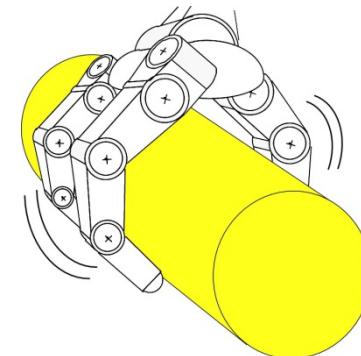
包み込み把握



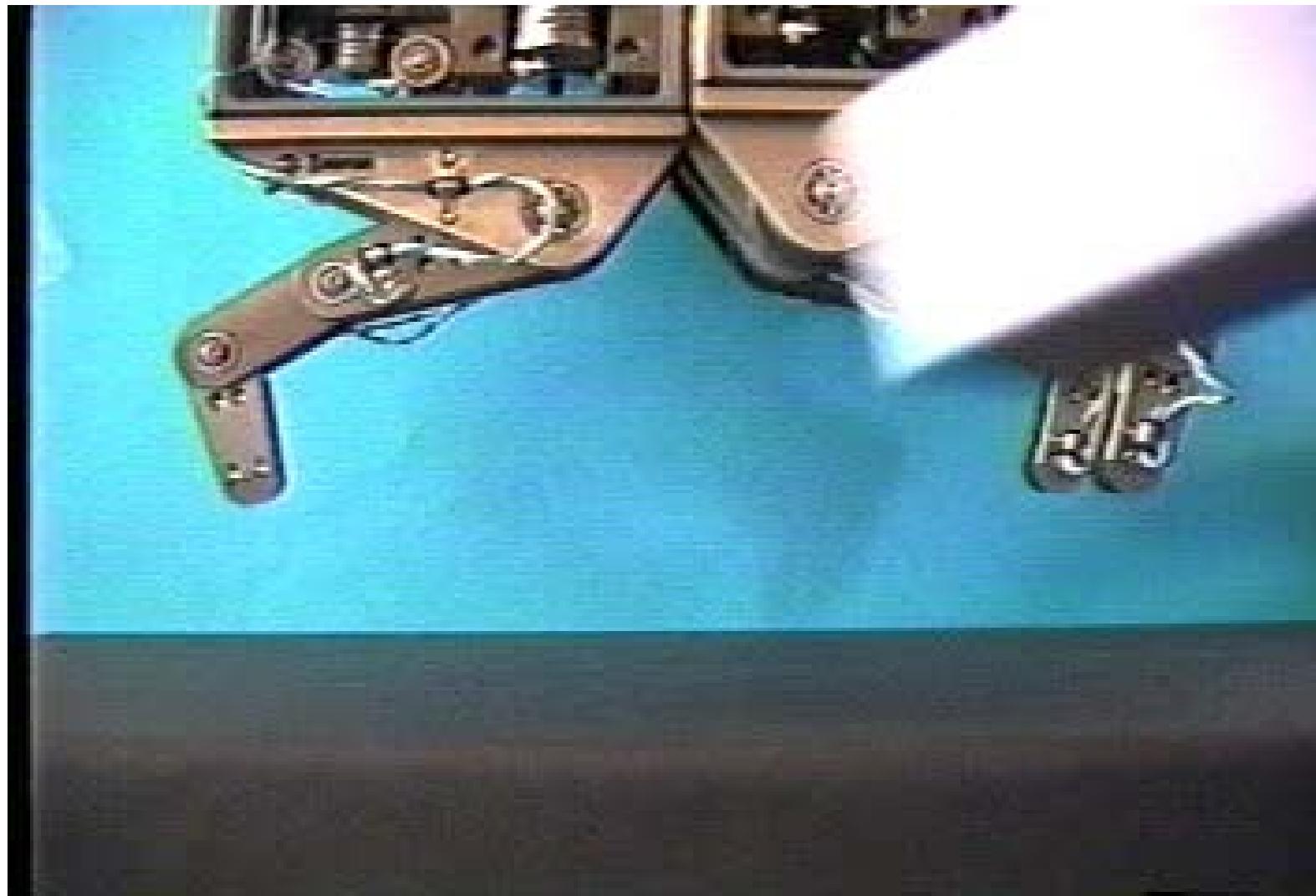
グリッパ



指先操り

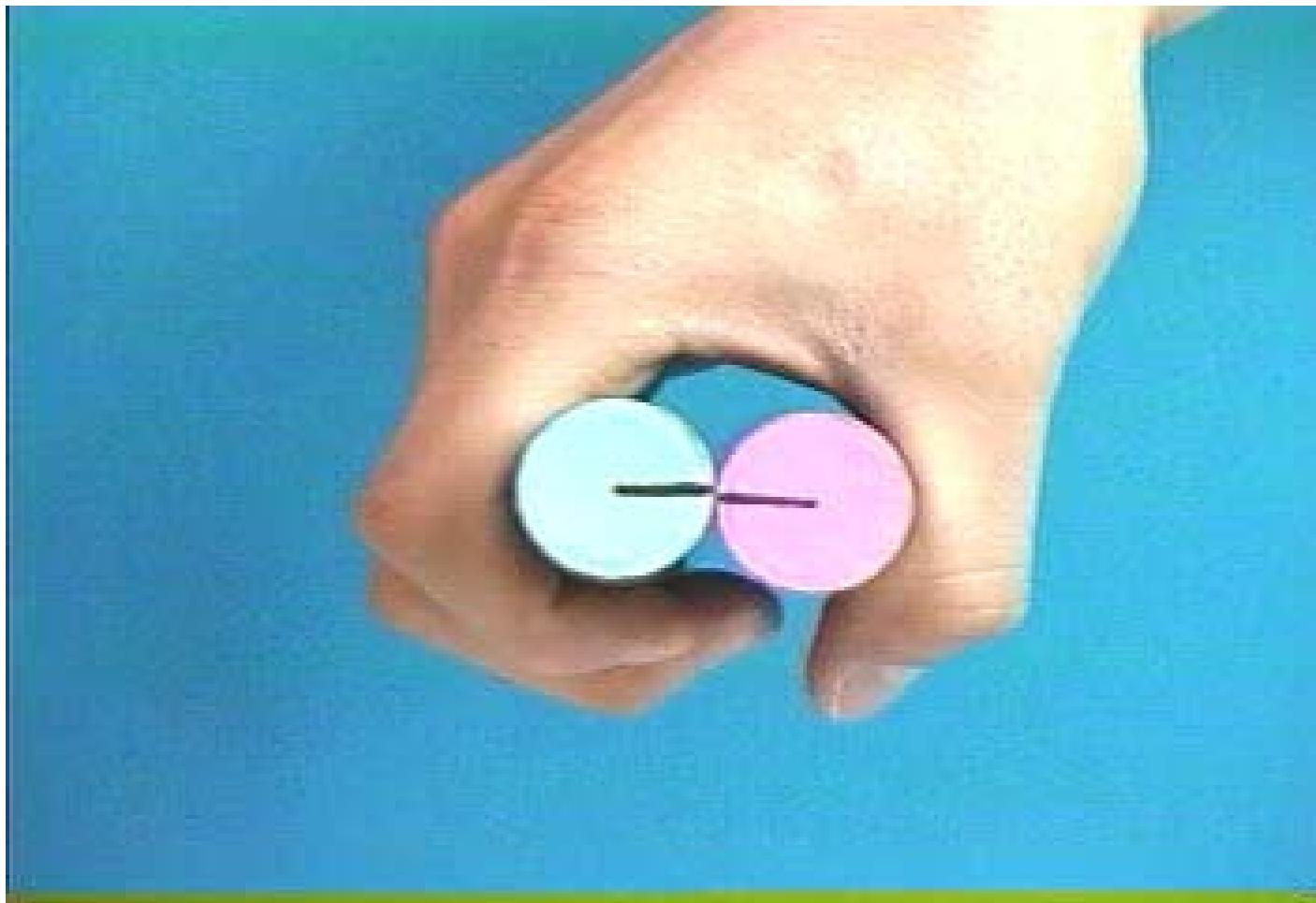


3本指把握



Kaneko and Nui (1996)

複数対象物の把握



Kaneko, Harada, and Tsuji (1999)

4本指ハンドによる蓋あけ



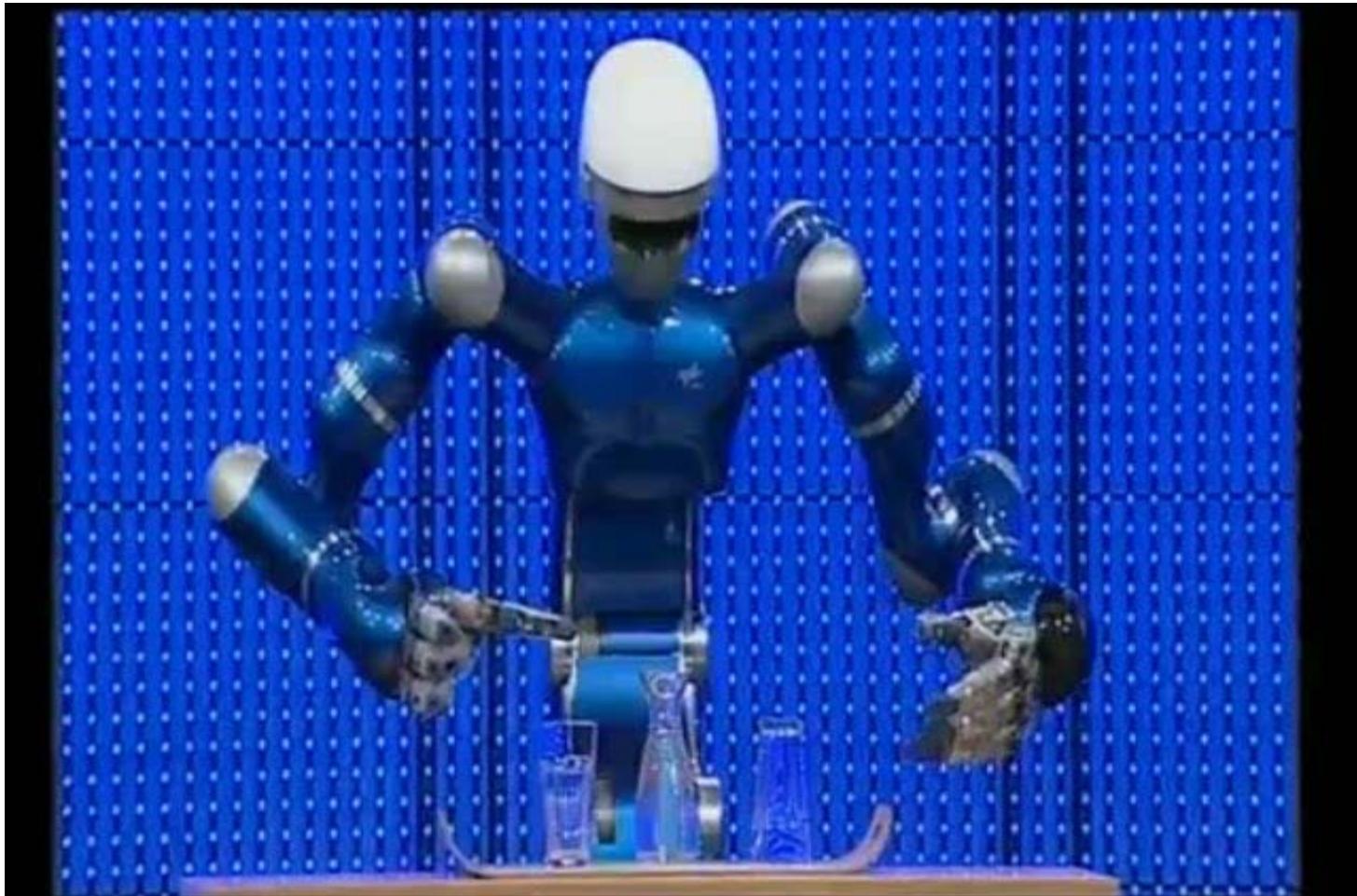
Jeong, Higashimori, and Kaneko (2003)

高速3本指ハンド



Namiki, Ishikawa and Kaneko (2004)

DLR-Hand



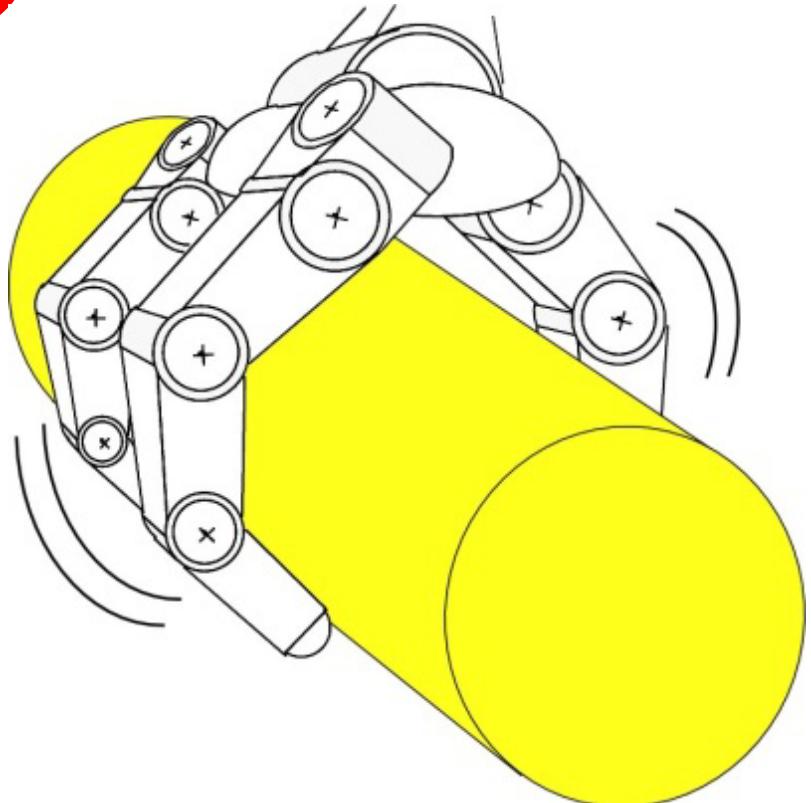
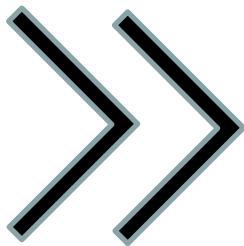
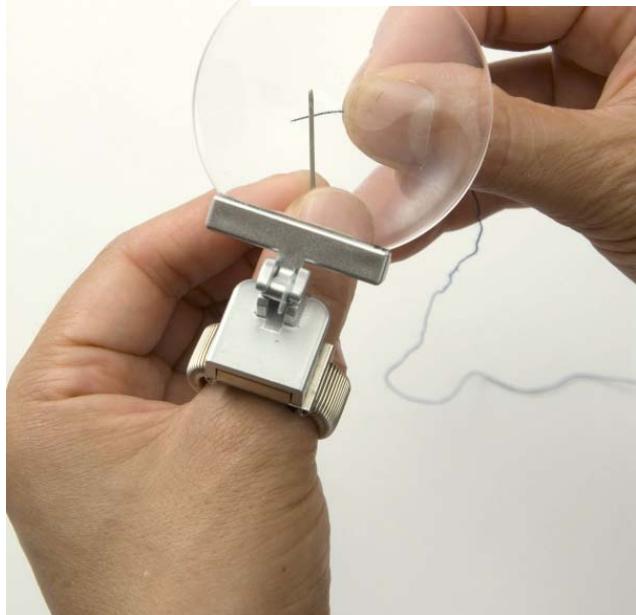
Hirzinger and others (2011)

ヒトによるペン状物体の超高速操り

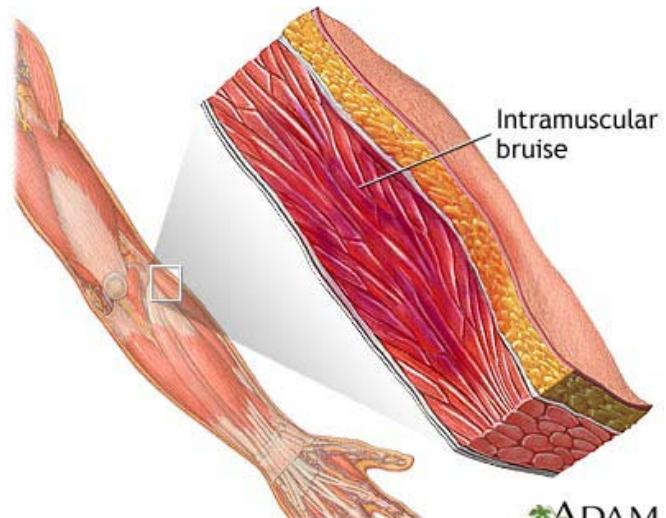
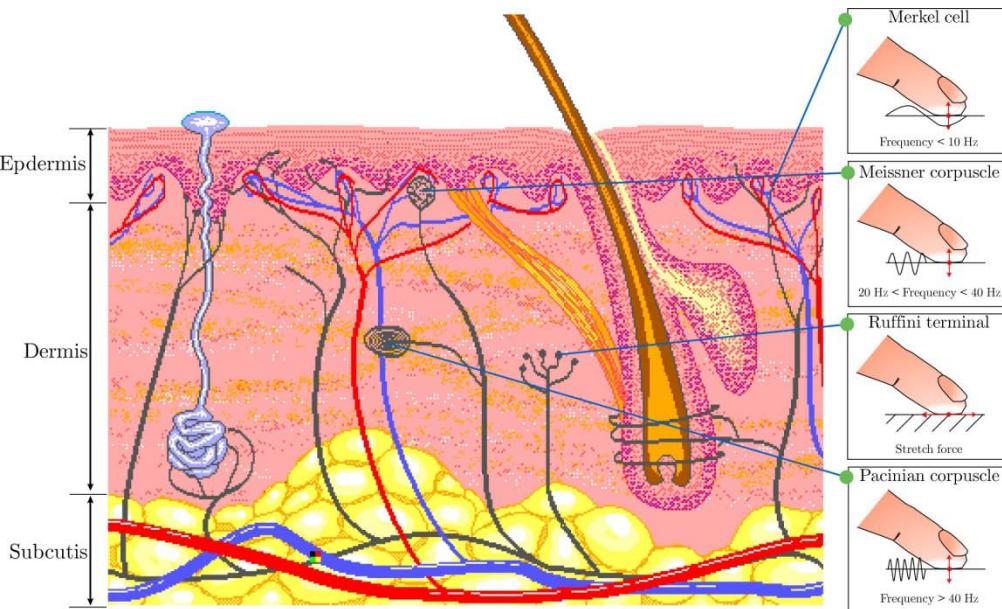
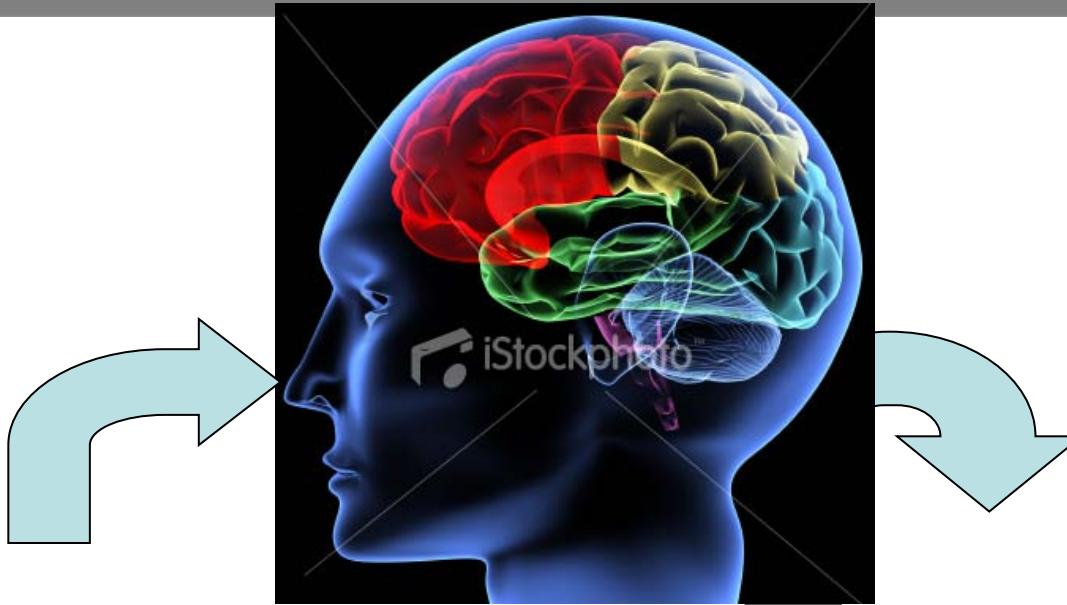


ヒトの指先把握の器用さは絶大!!

Why?



ヒトの指先把握の器用さを支える

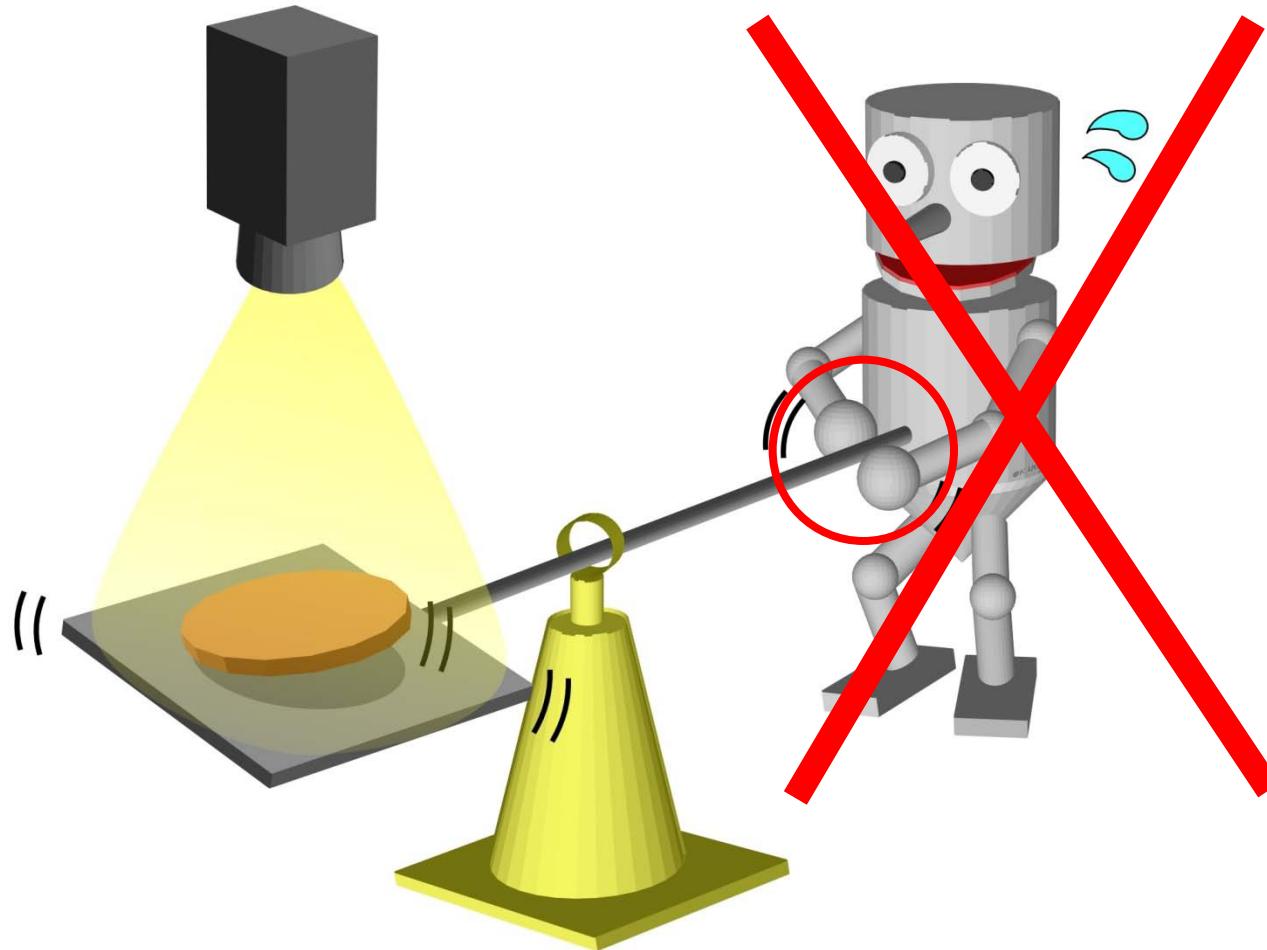


ADAM

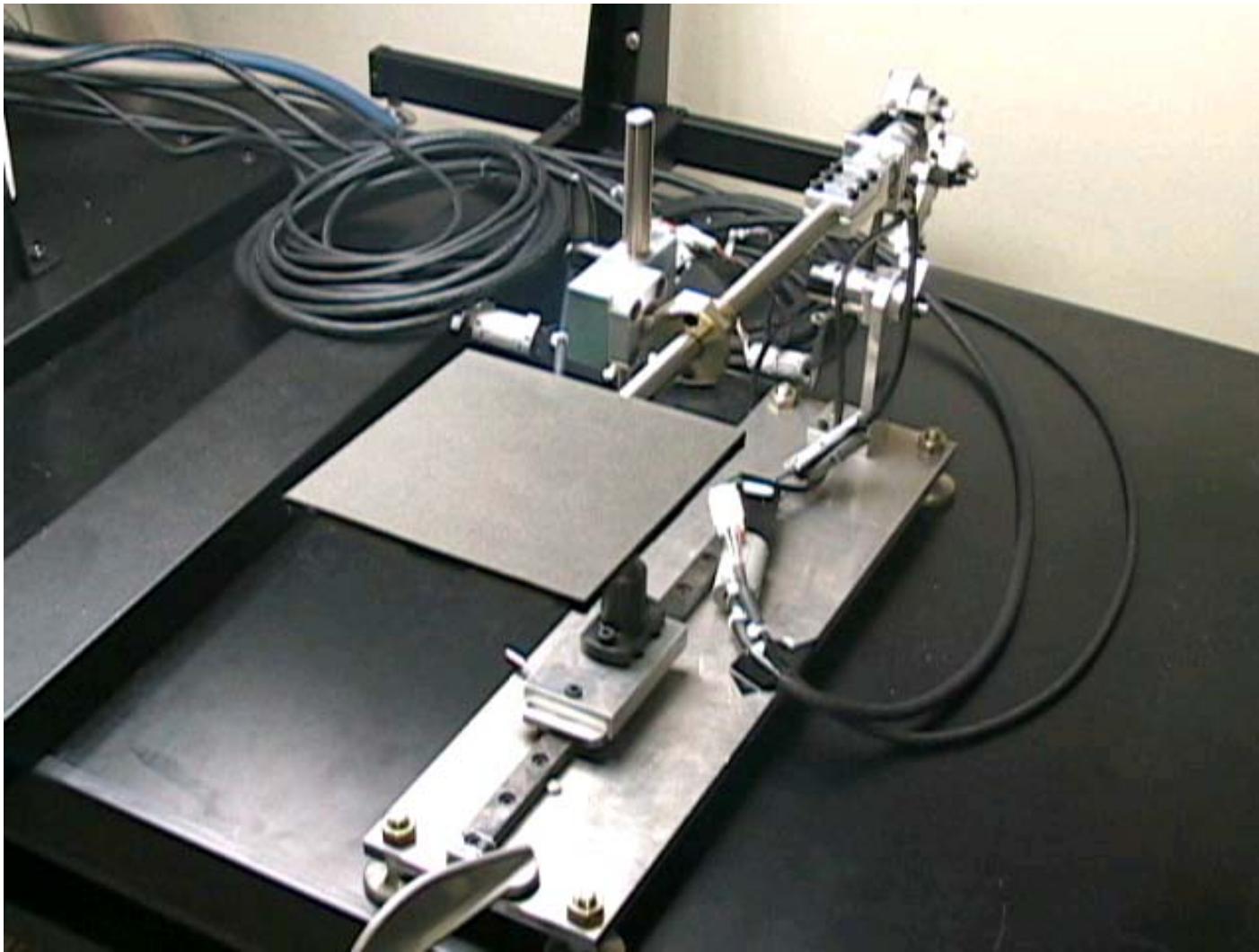
ピザマスターの器用な操り



ピザ操りロボット

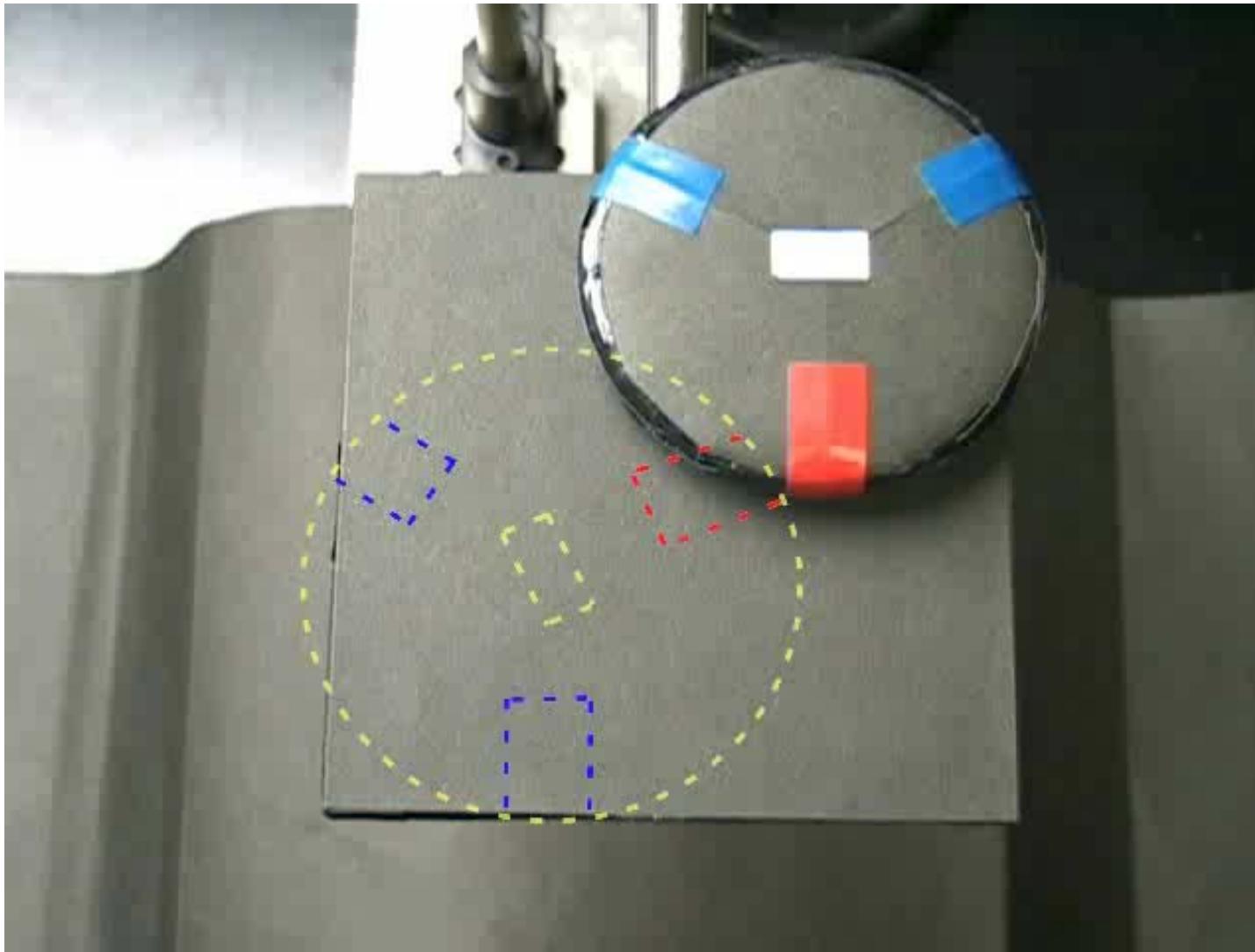


バイオミメティックからはずれた発想

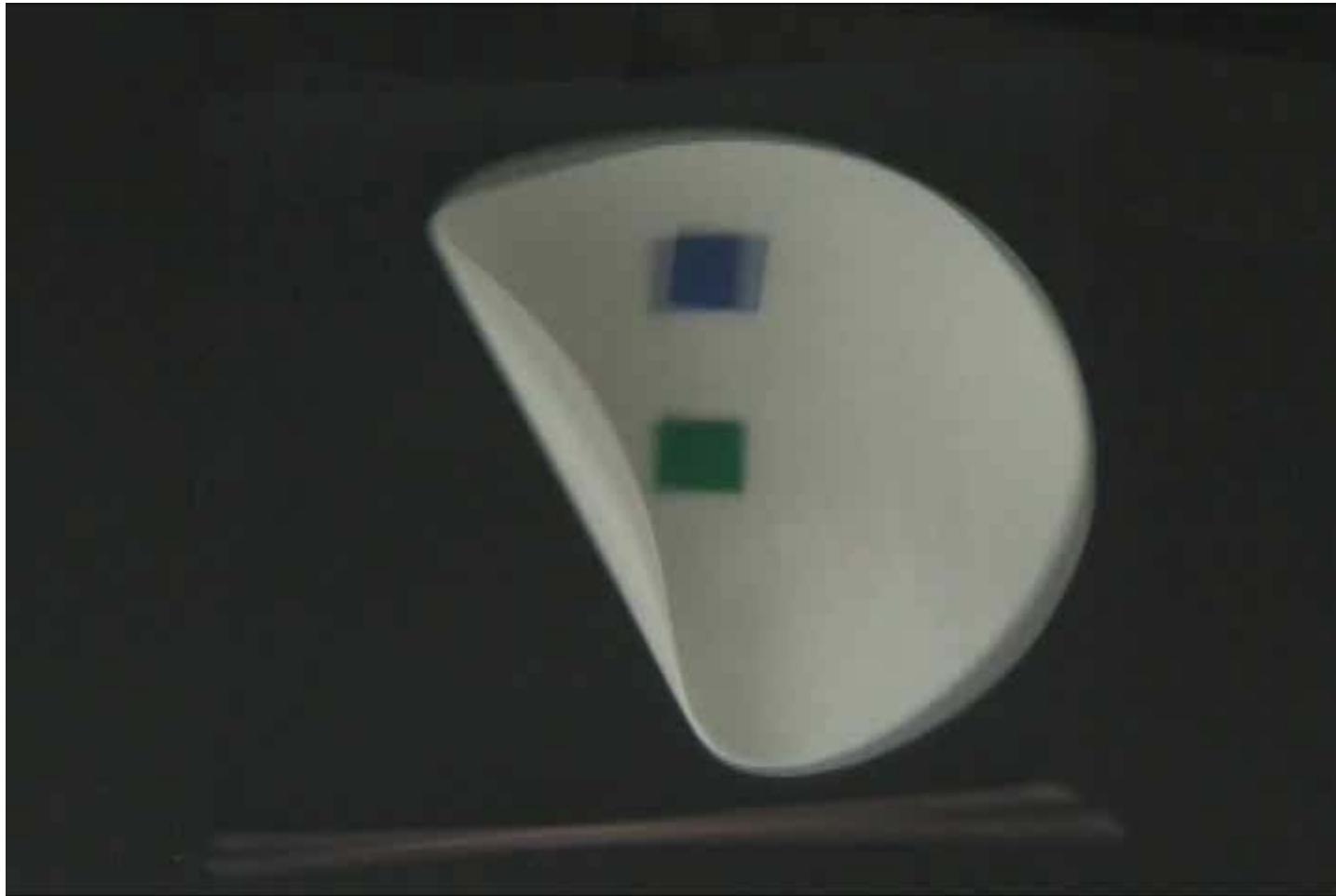


Higashimori and Kaneko (2006)

円盤対象物の操り



柔軟物体の回転操作



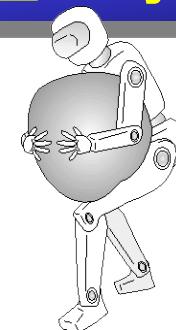
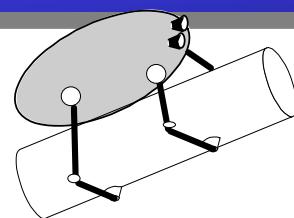
Higashimori, Omoto and Kaneko (2009)

柔軟物体の高速回転

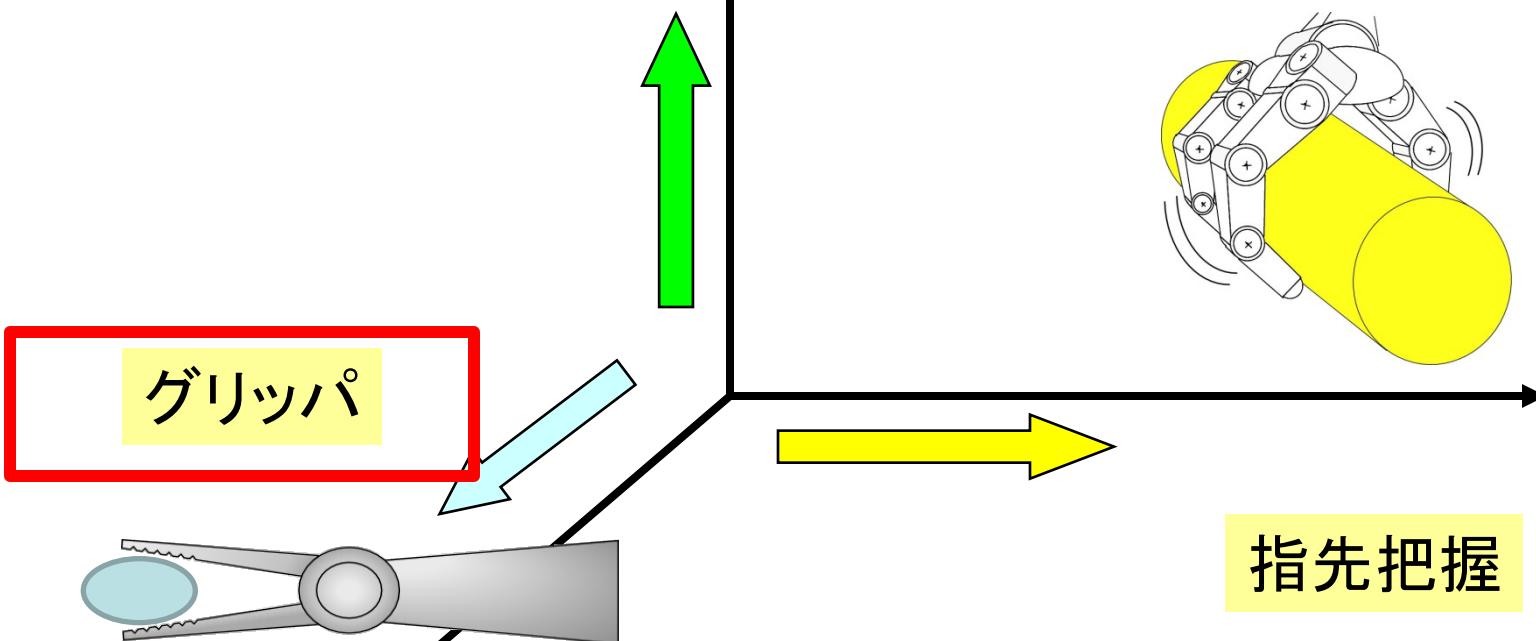


Higashimori and Kaneko (2011)

把握と操り

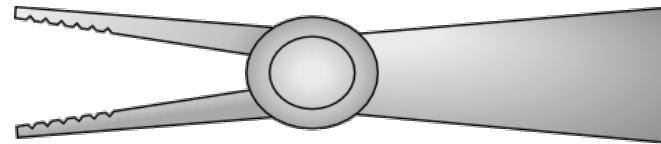
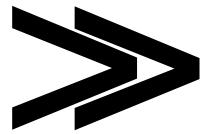


包み込み把握

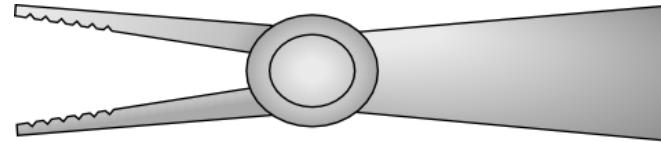
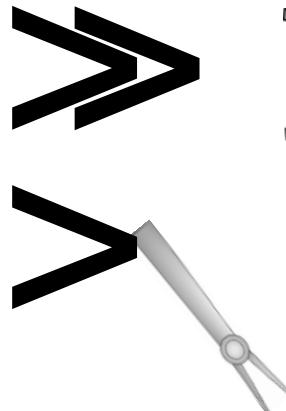


グリッパを使ってヒトを超えるか？

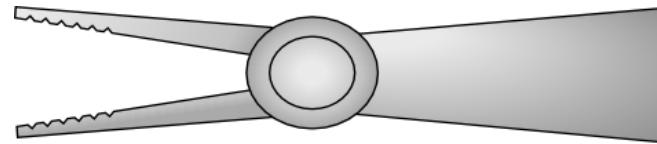
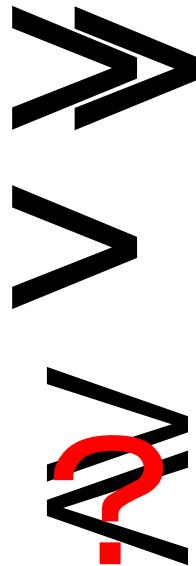
器用性



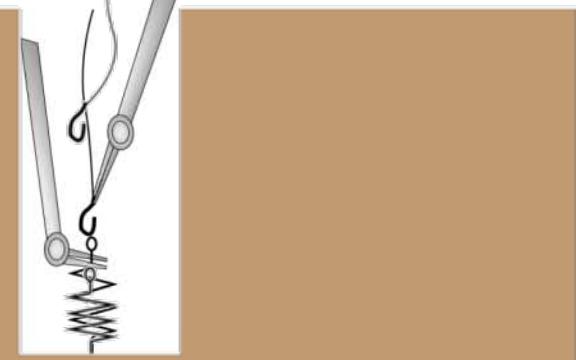
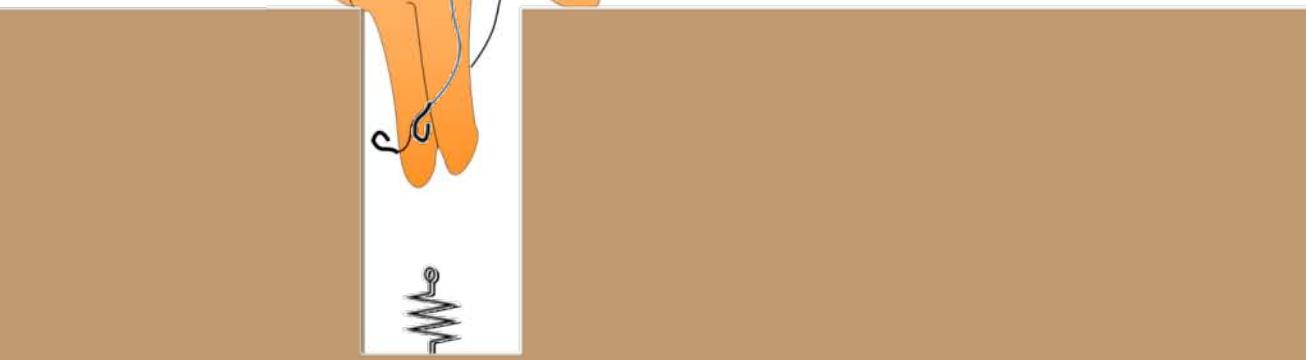
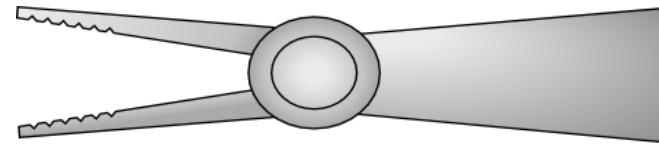
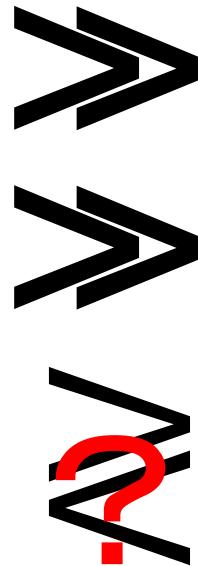
器用性



器用性



器用性



da Vinci



前立腺がん: 70%以上の手術はda Vinciで行われている。

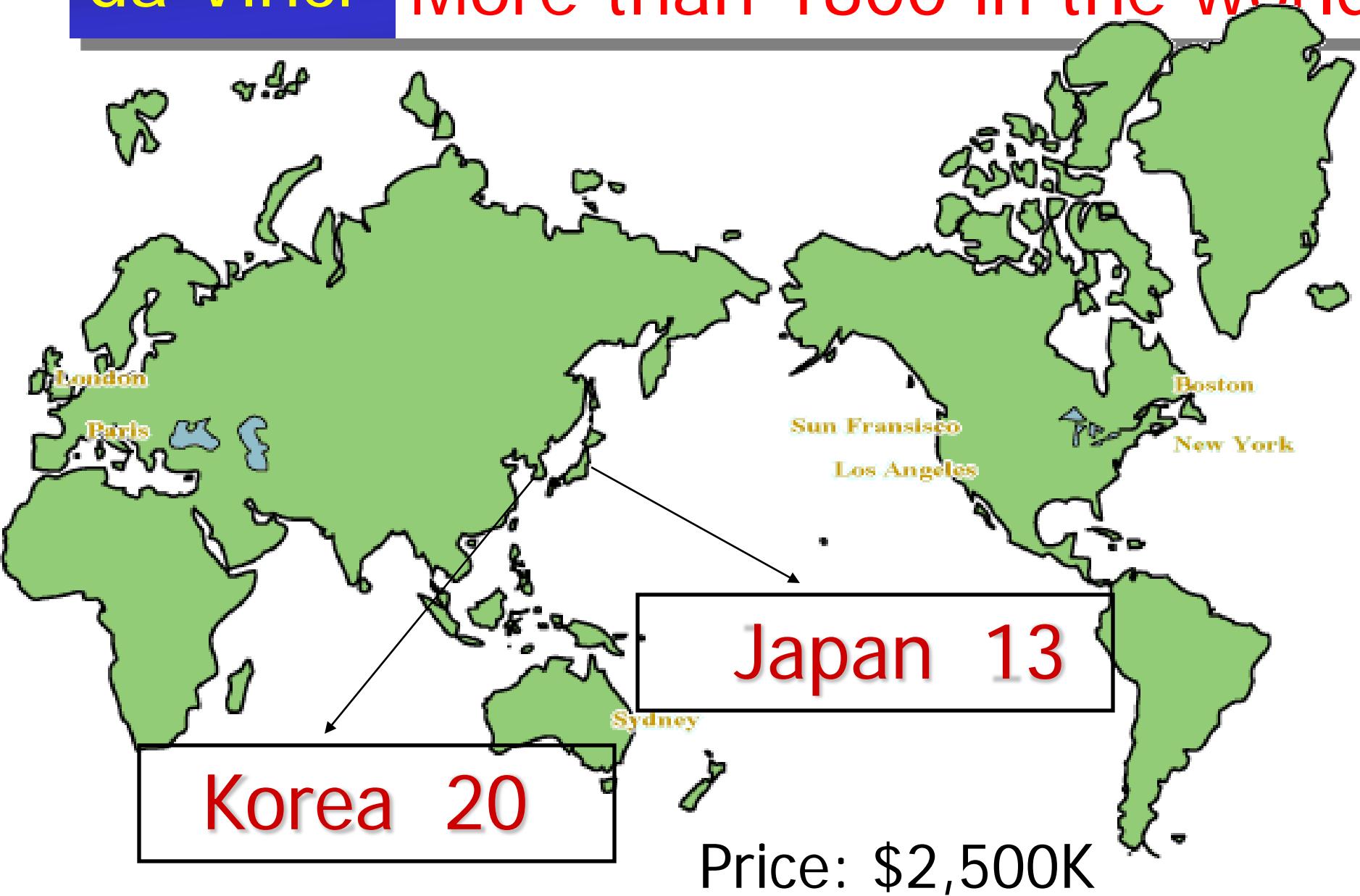
なぜ da Vinci?



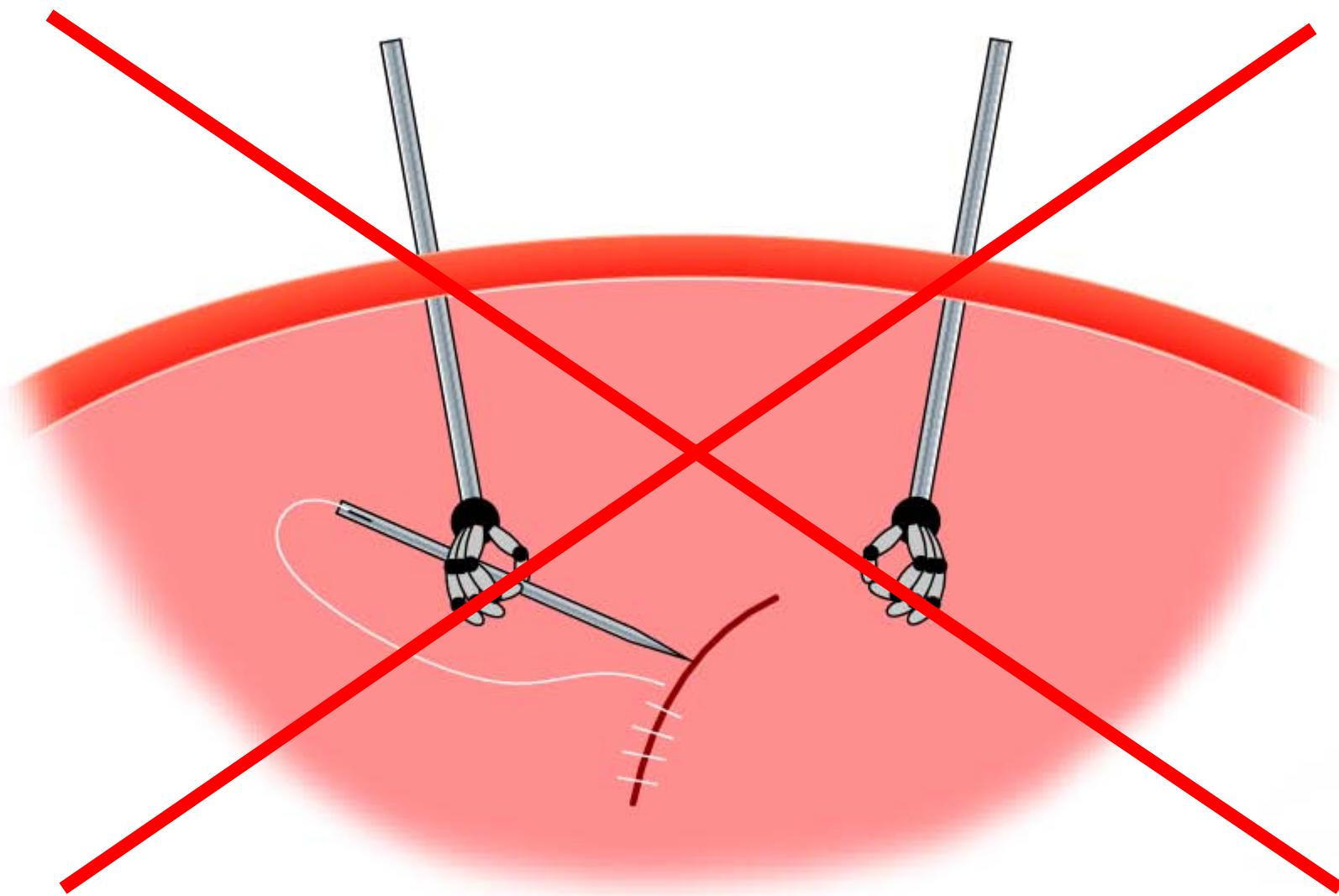
Manual Operation
Success rate: **80%**



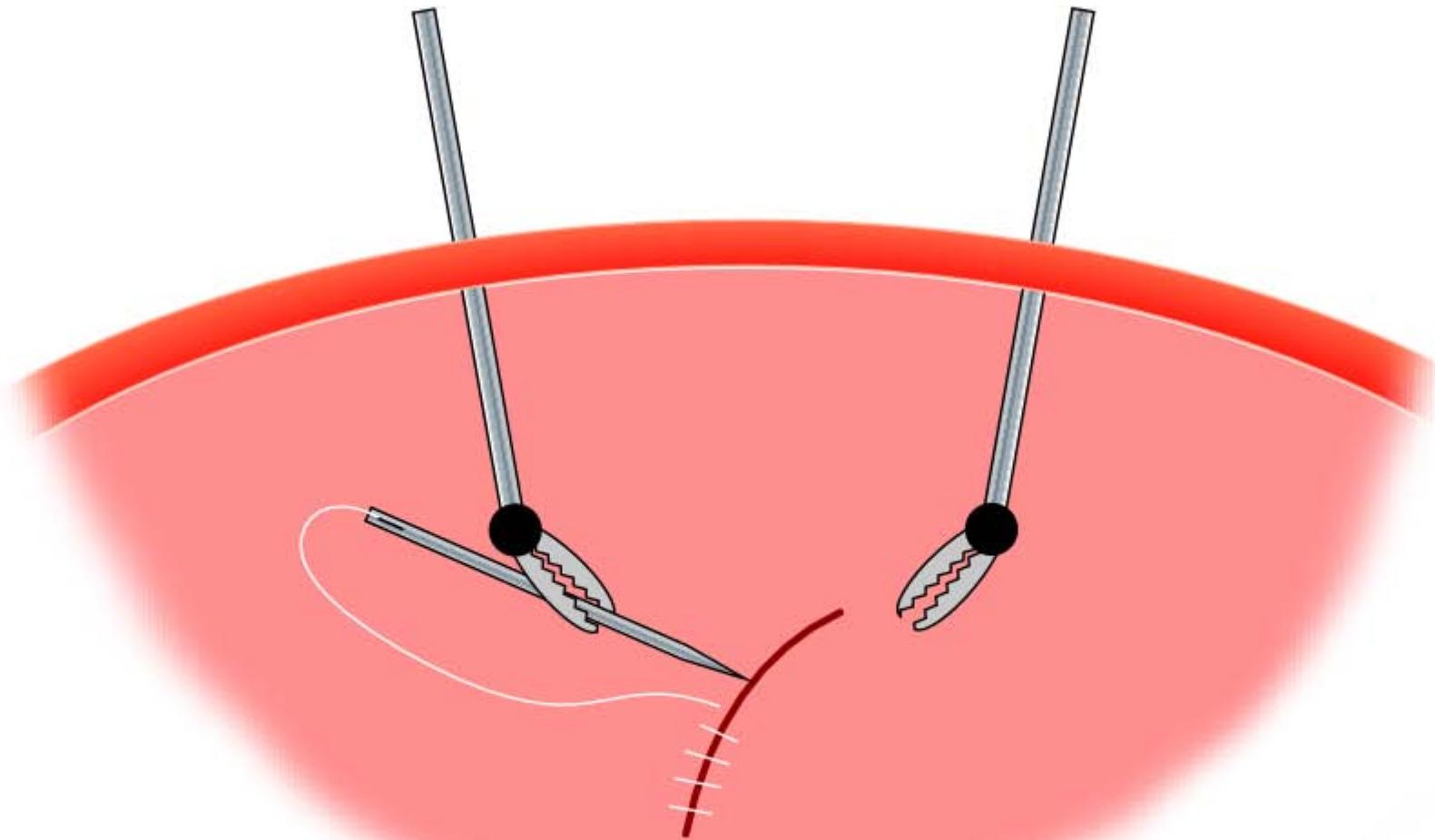
Robot Operation
Success rate: **95%**



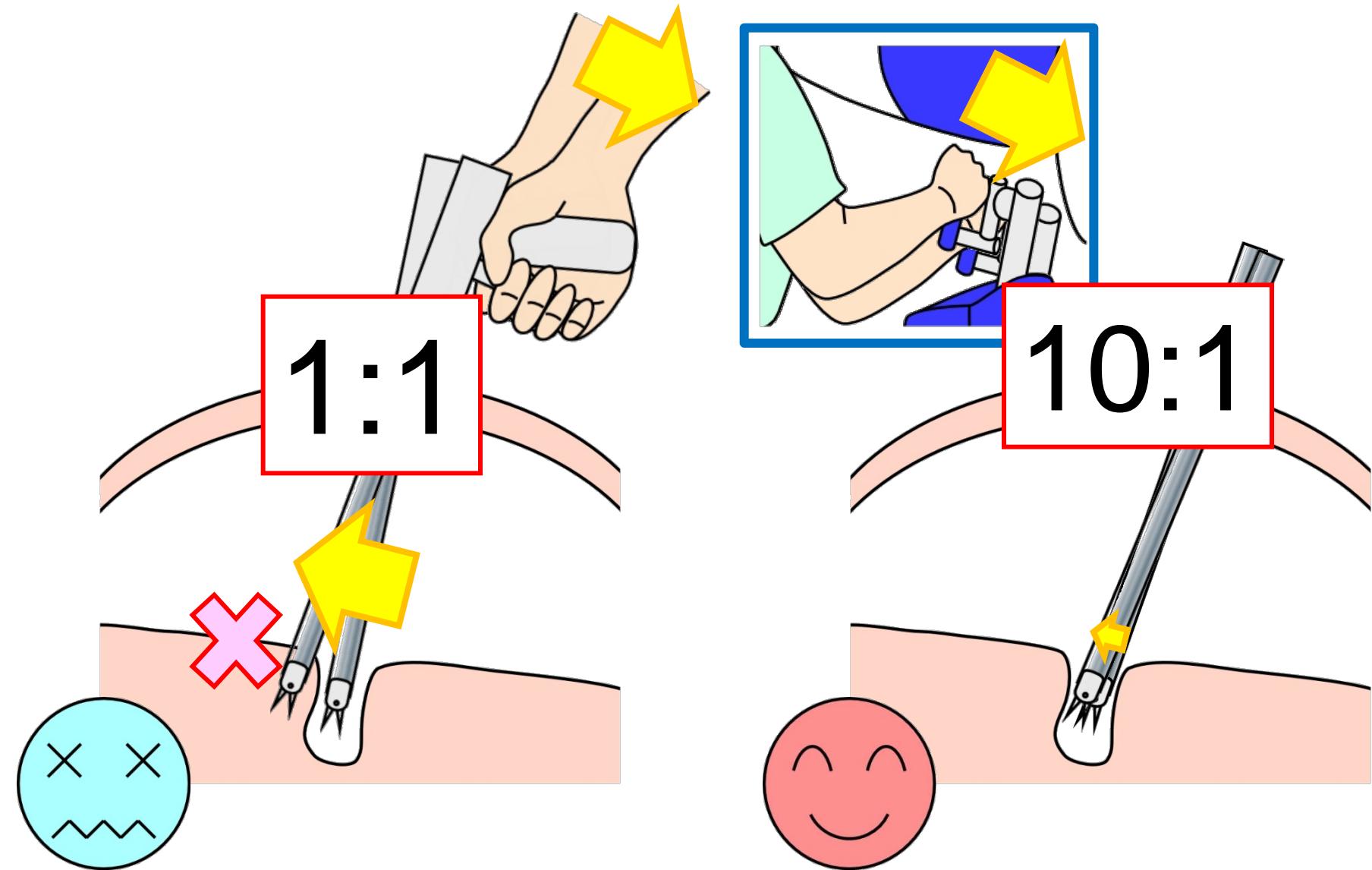
ヒトの手を真似ると…



(アーム+グリッパ)X2 → 器用性



運動のスケーリング



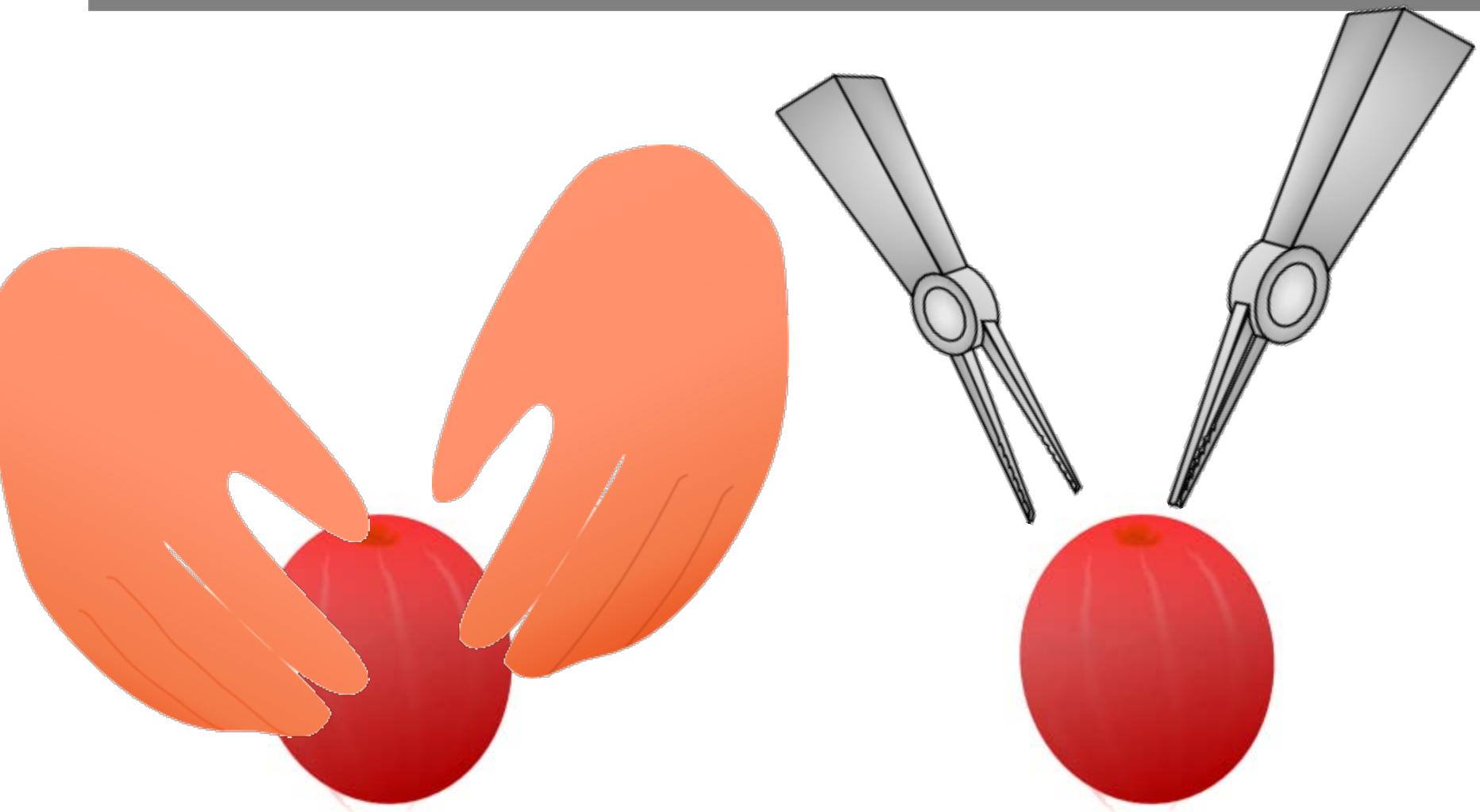
da Vinci でぶどうの皮を剥く

http://www.youtube.com/watch?v=vThf_sEWndU

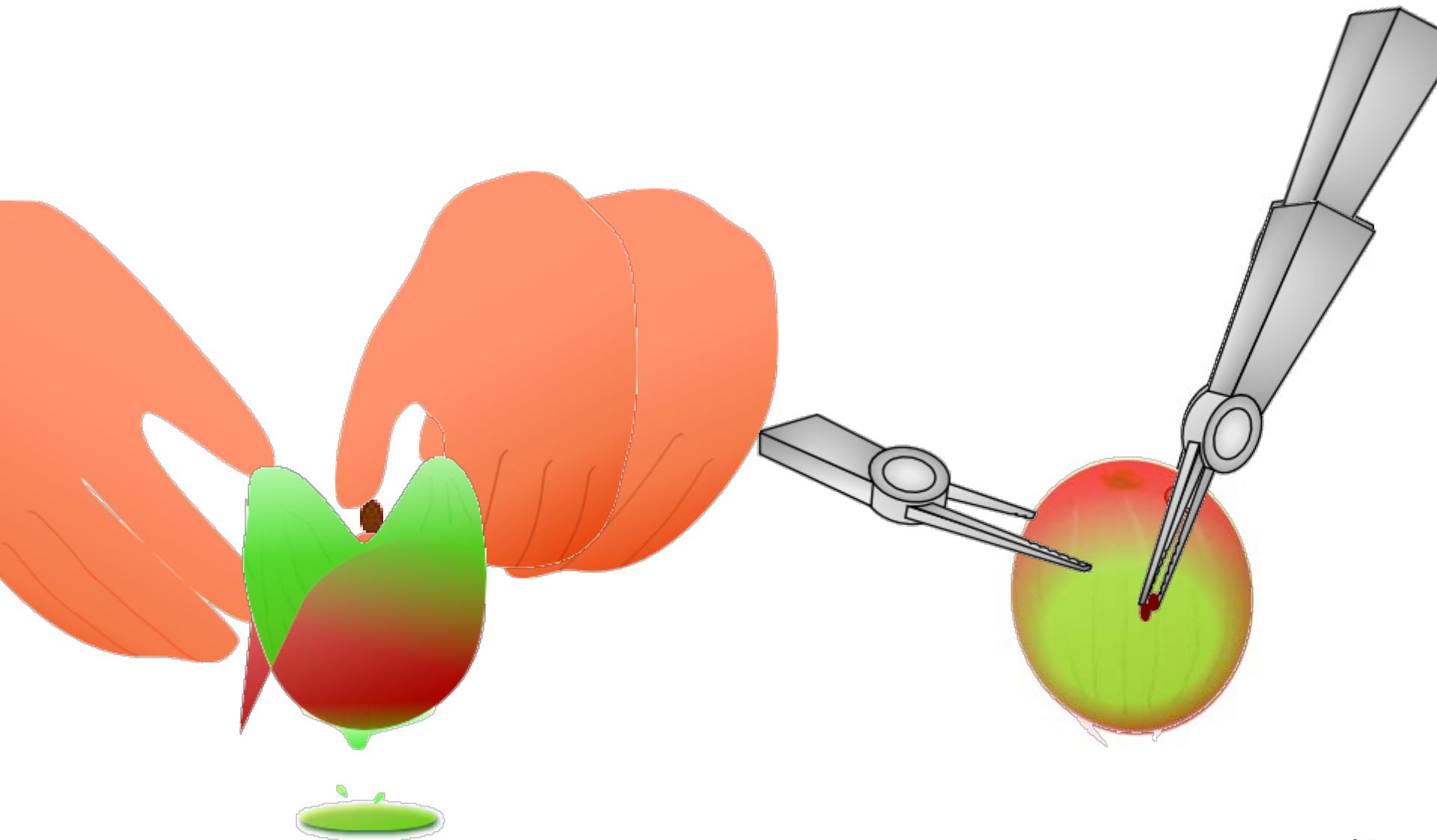


もしぶどうの種だけ取るとしたら？・・・

ブドウから種を取り出す



ブドウから種を取り出す

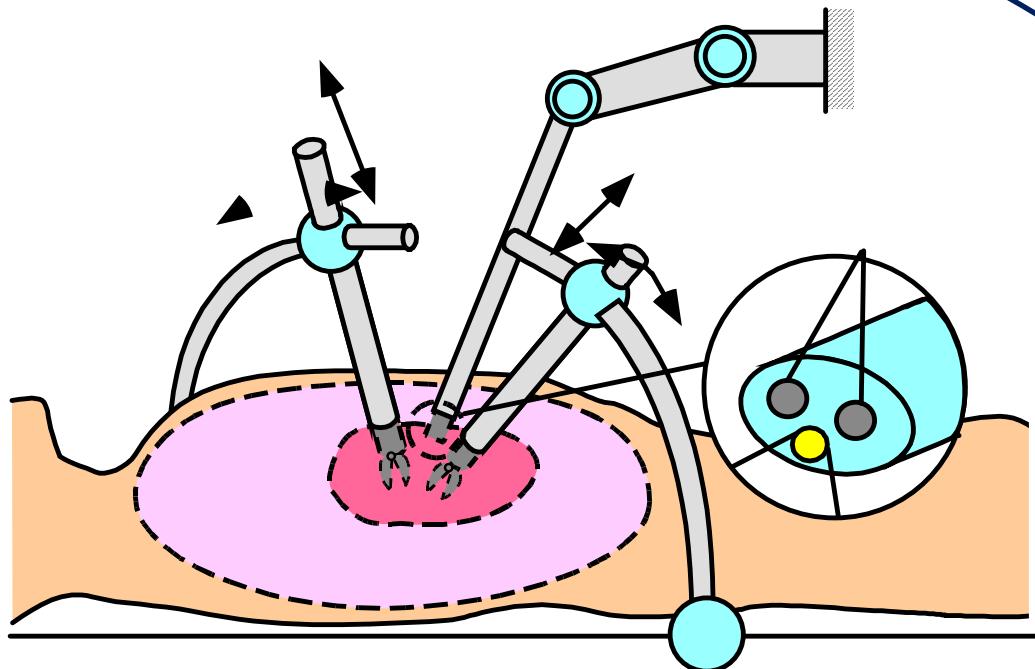


ヒトとロボットの協調

ヒトの能力の拡張

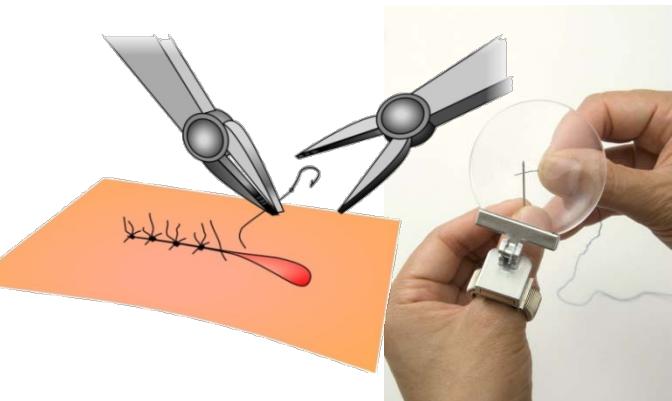


運動計画



正確な動作の実現

バイオミメティックapro- ローチ



↓ ゴール志向



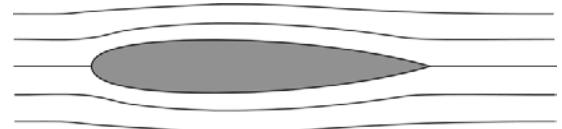
Low



↓ 機能真似



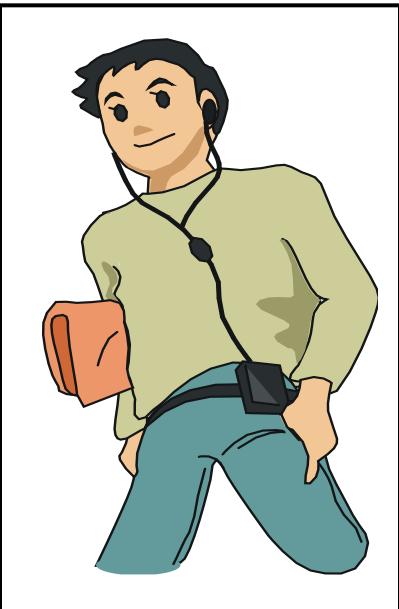
↓ 形真似



High

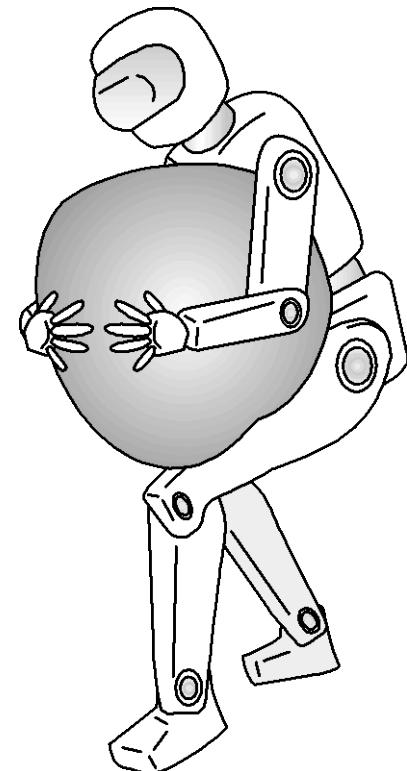
バイオミメティックレベル

Beyond Human

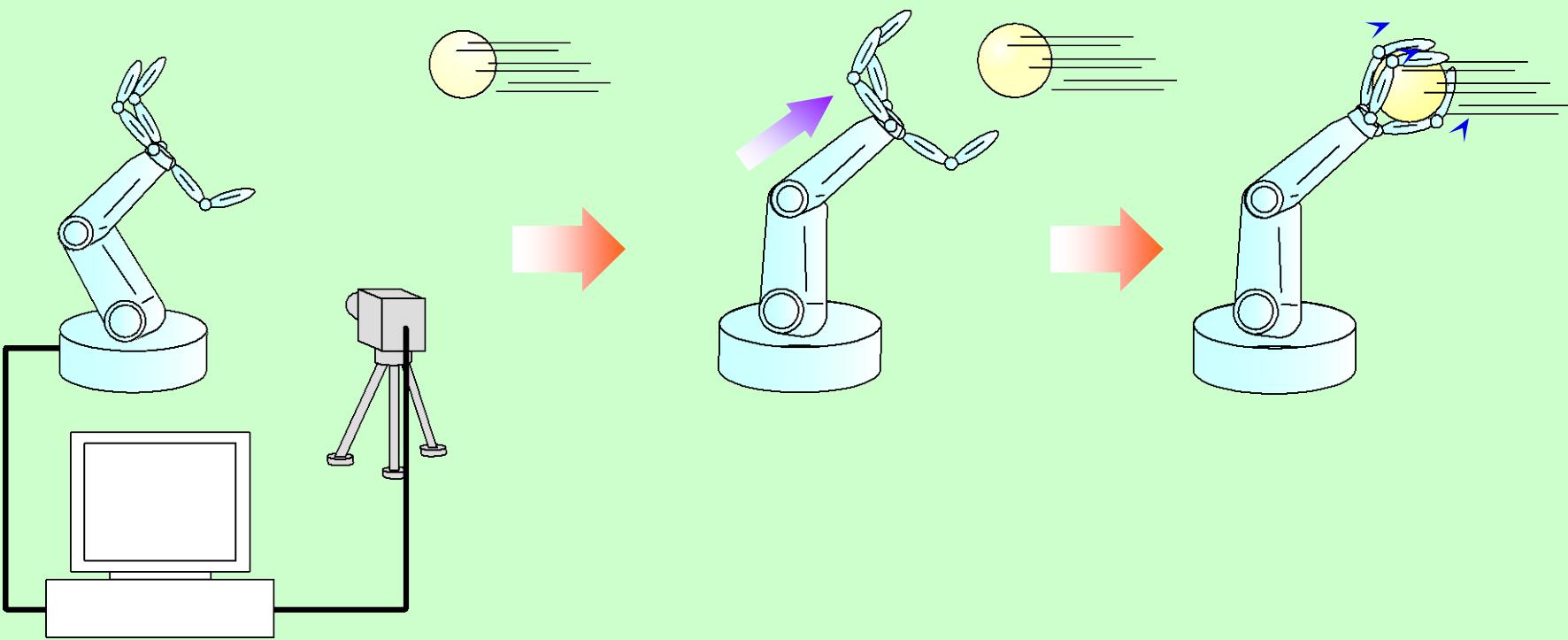


<

速度 or
加速度

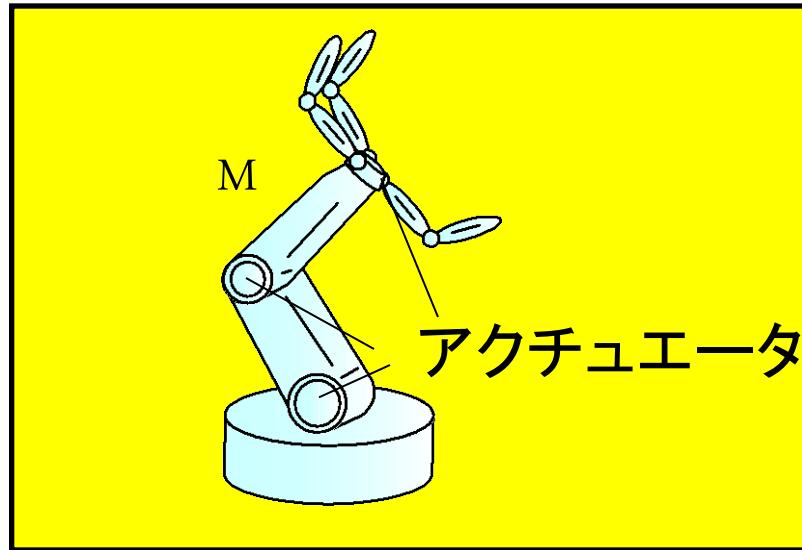


超高加速度キャッチングロボット



Capturing System

高加速度をどうやって実現？



$$a = \frac{F}{M}$$

M : ロボット質量

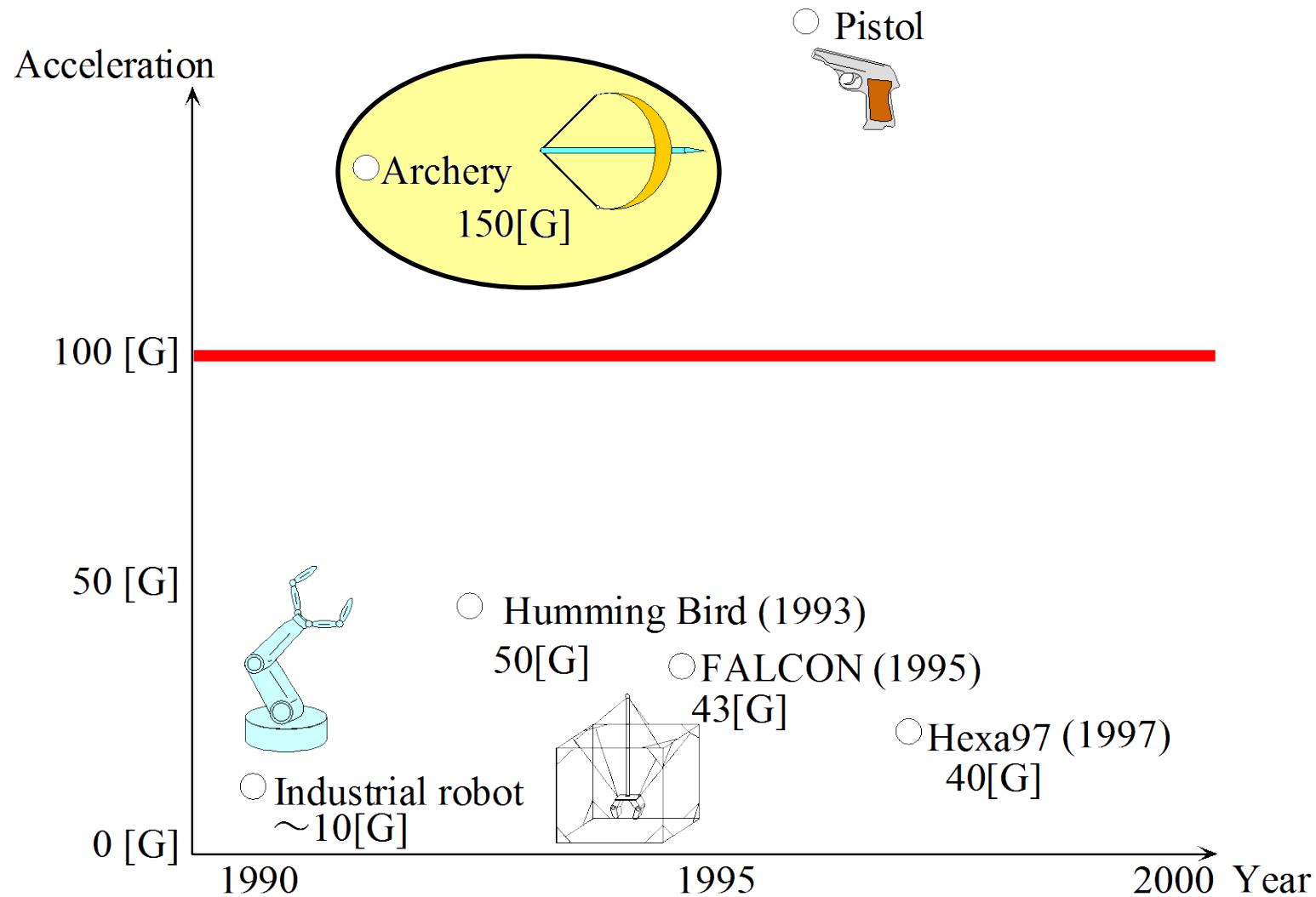
F : アクチュエータの推進力



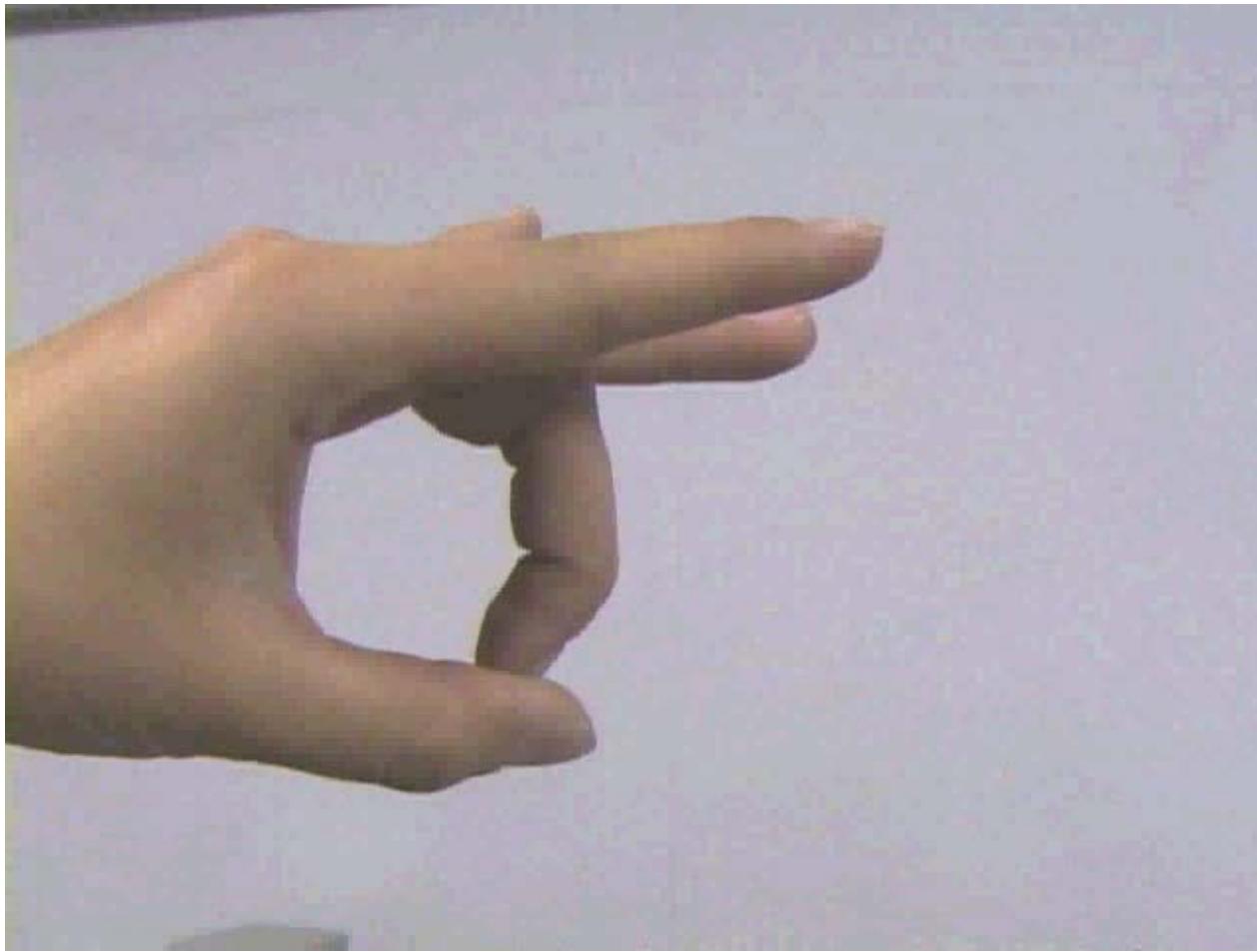
強力なアクチュエータ

軽量化

高加速度を実現したロボット



エネルギー蓄積型の一例

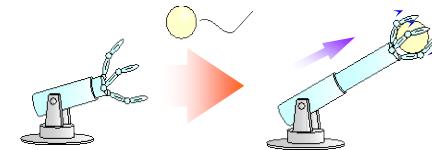


エネルギー蓄積型の一例

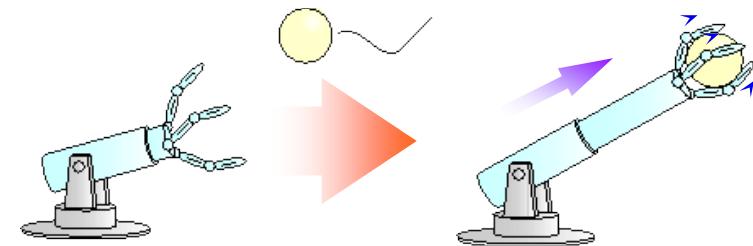


スケールは？

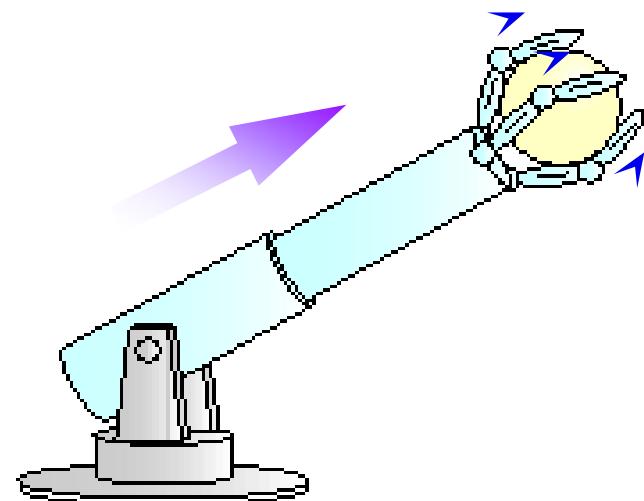
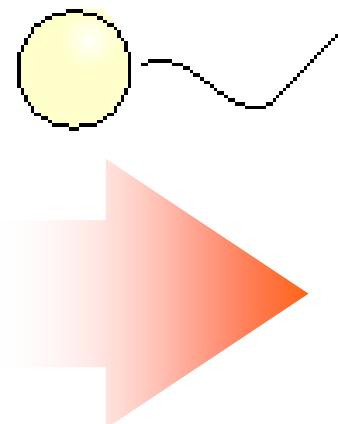
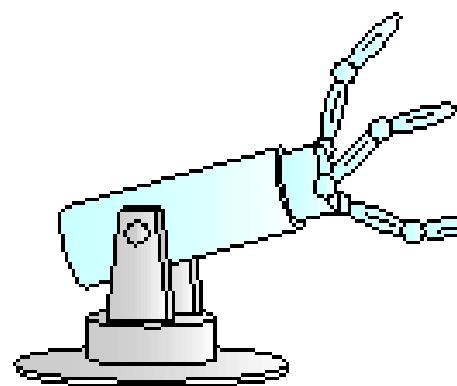
$F=10N, M=0.01Kg$



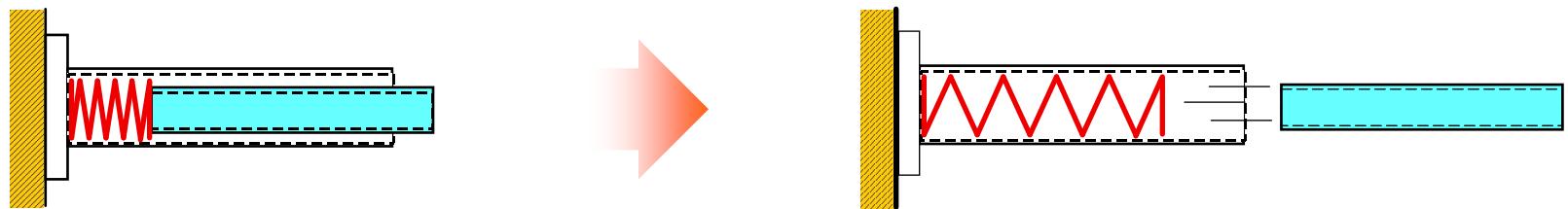
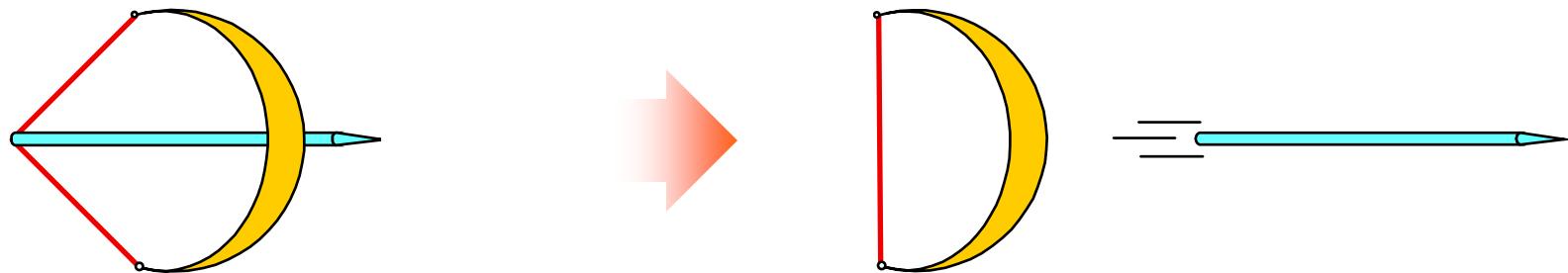
$F=100N, M=0.1Kg$



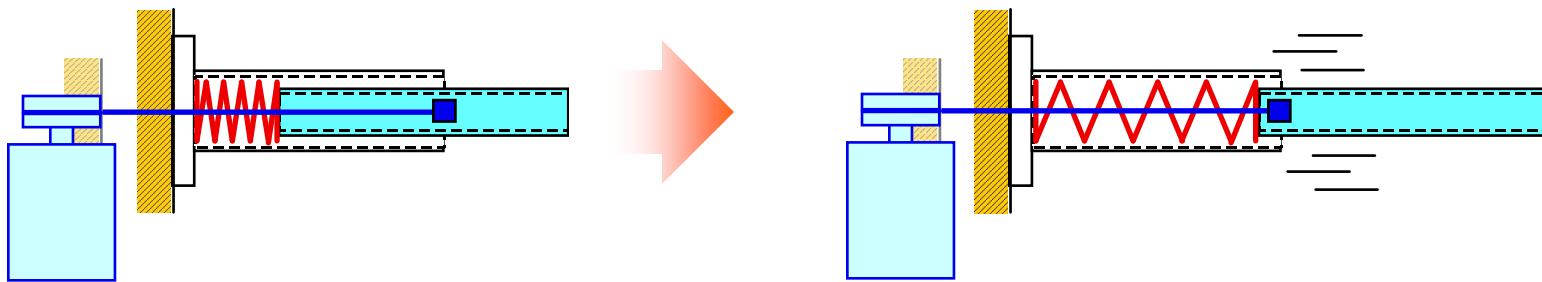
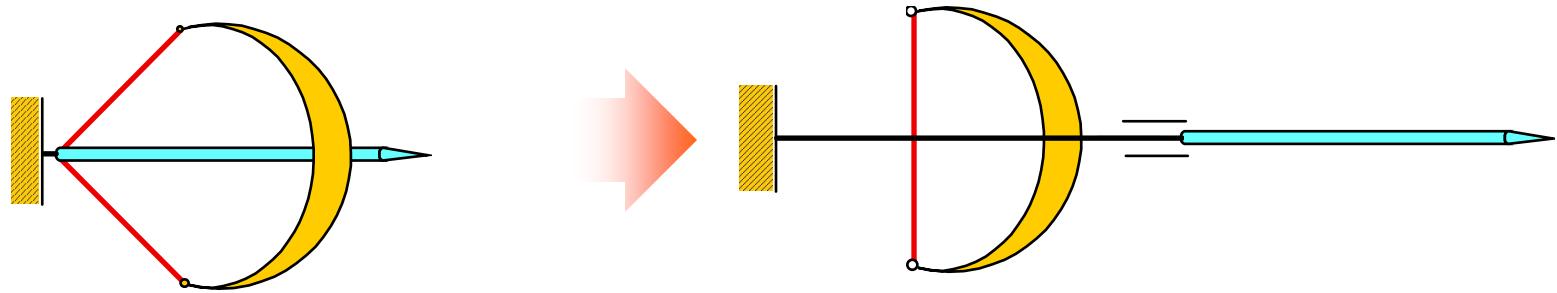
$F=1000N, M=1.0Kg$



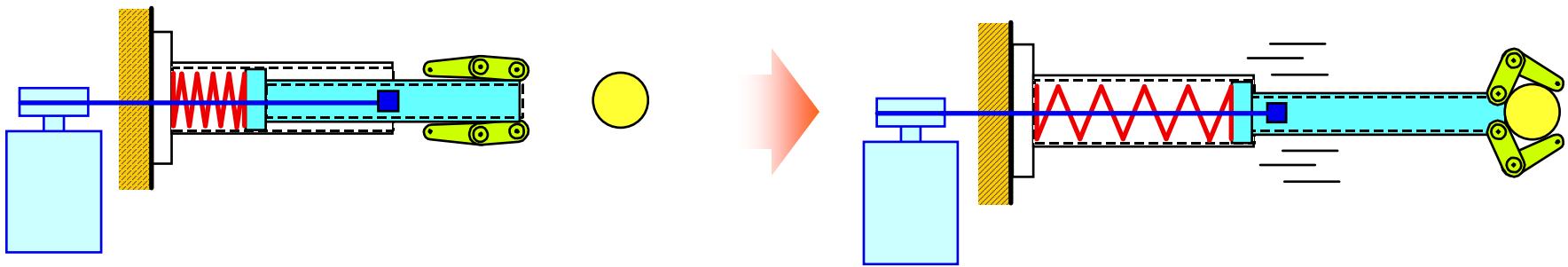
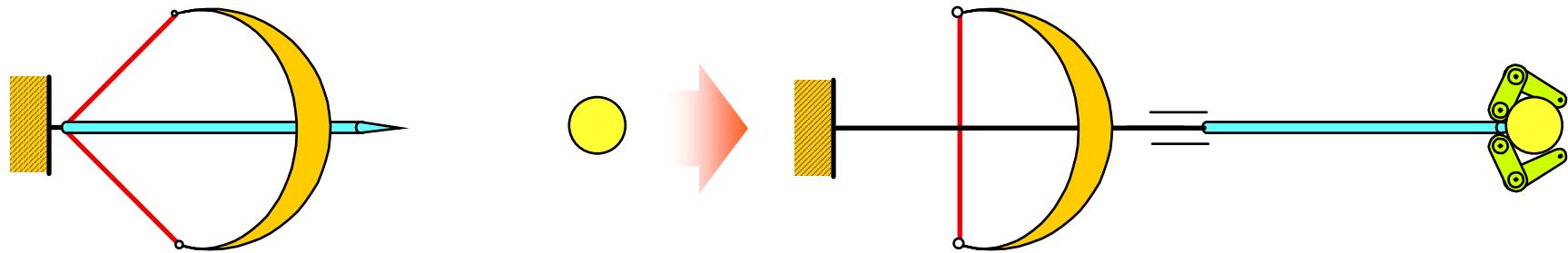
アーチェリーをお手本に・・・



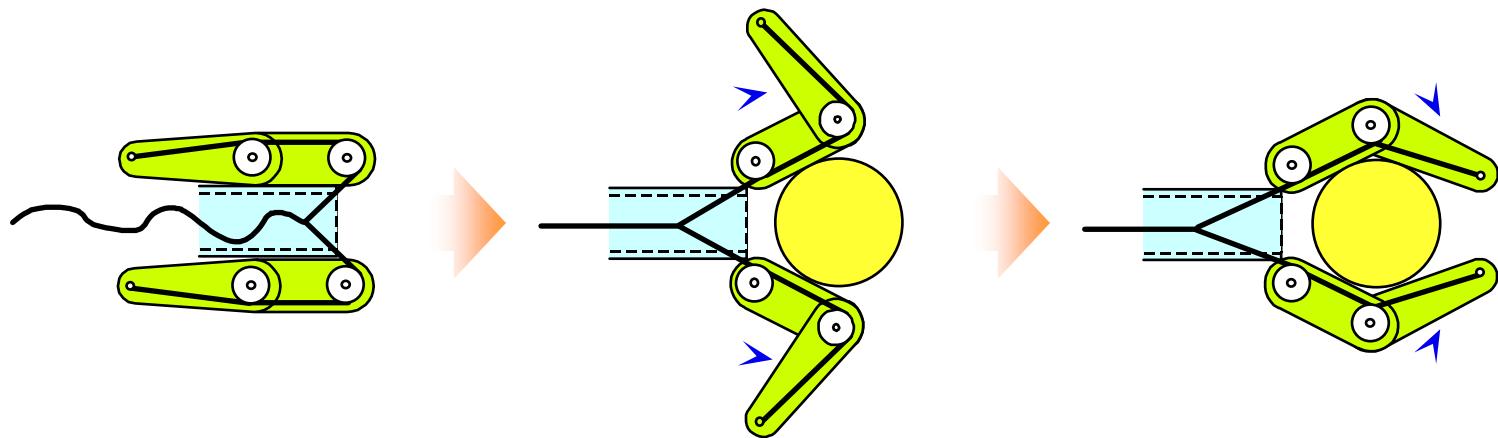
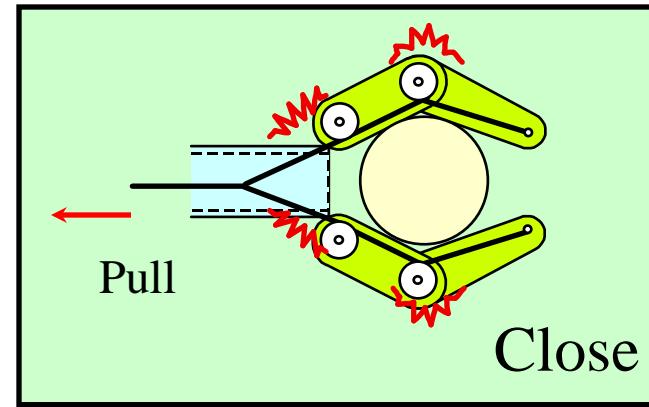
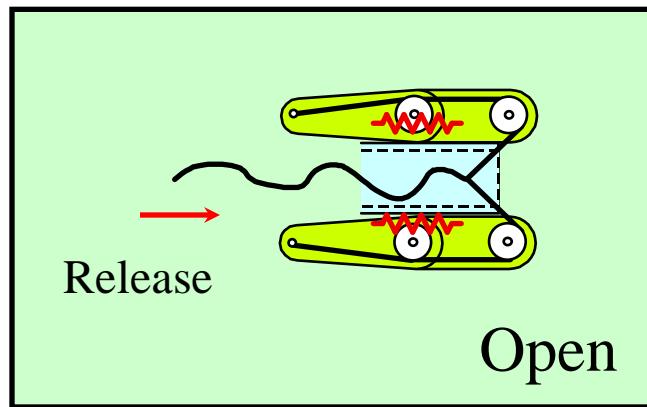
アームの位置決め機構



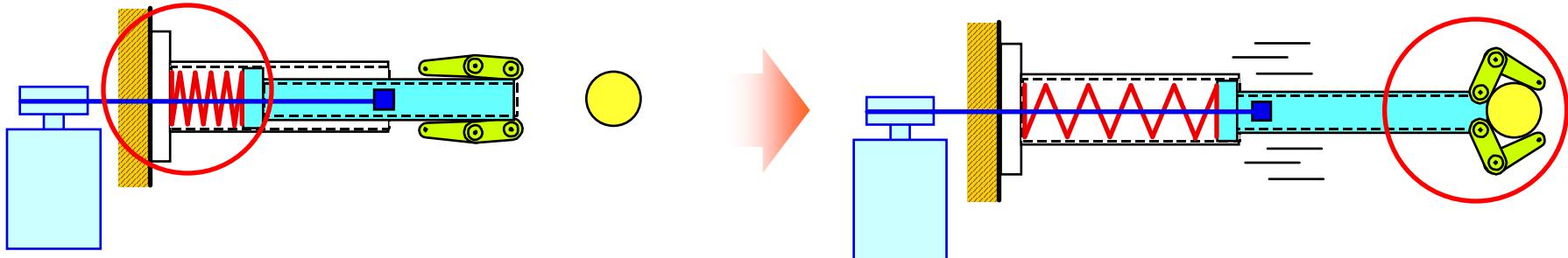
ハンド部の導入



1能動自由度ロボットハンドの機構



解決すべき問題点



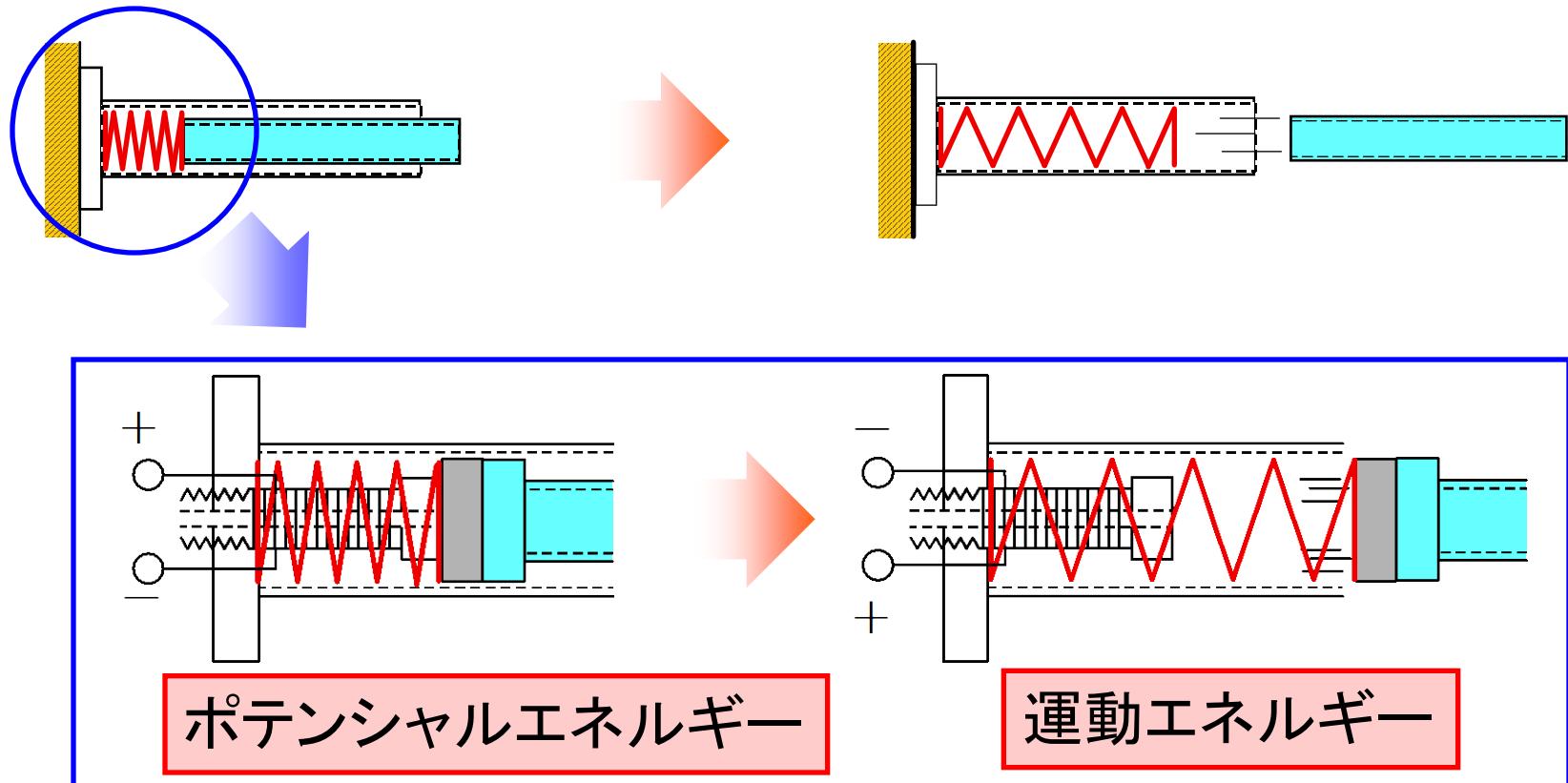
- ・エネルギー保持機構
- ・ハンドの設計
- ・エネルギー伝達は？

初期運動エネルギー

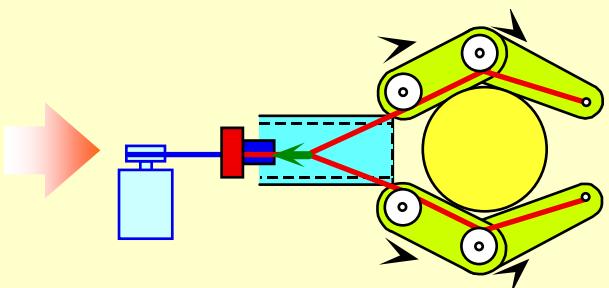
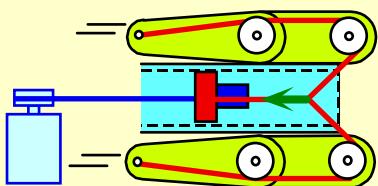
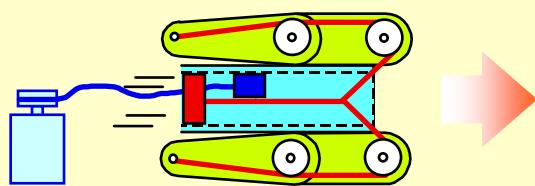
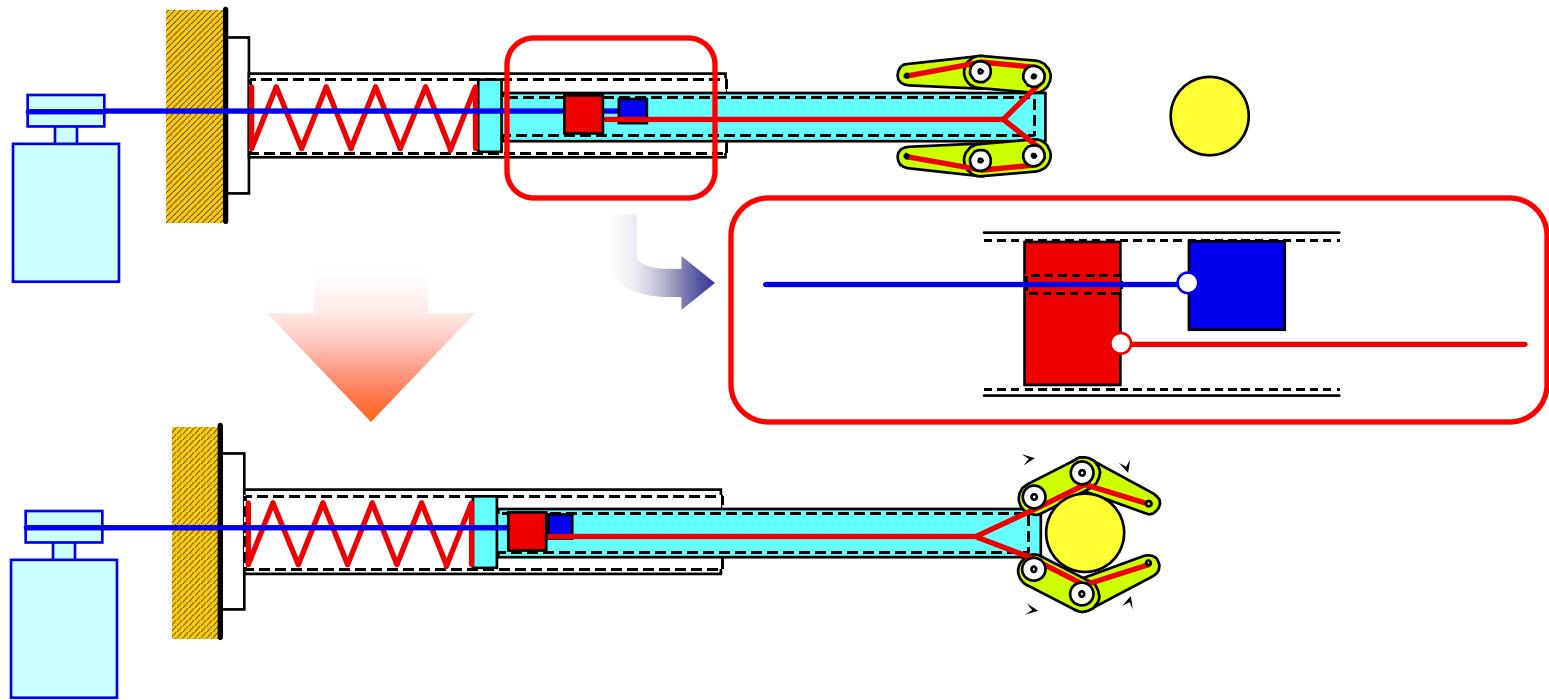


ハンド閉動作の運動エネルギー

エネルギー伝達機構



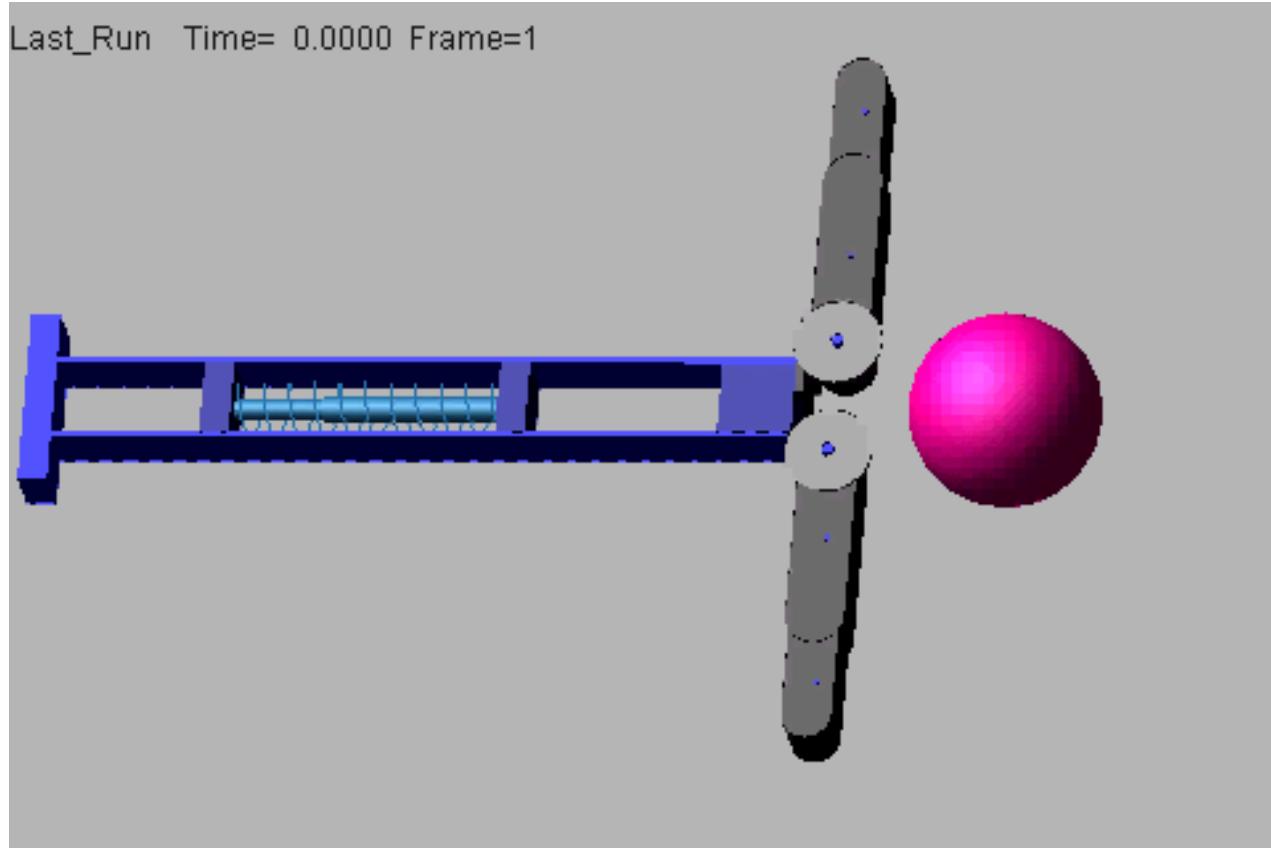
エネルギー伝達カップリング機構



アームの運動エネルギー

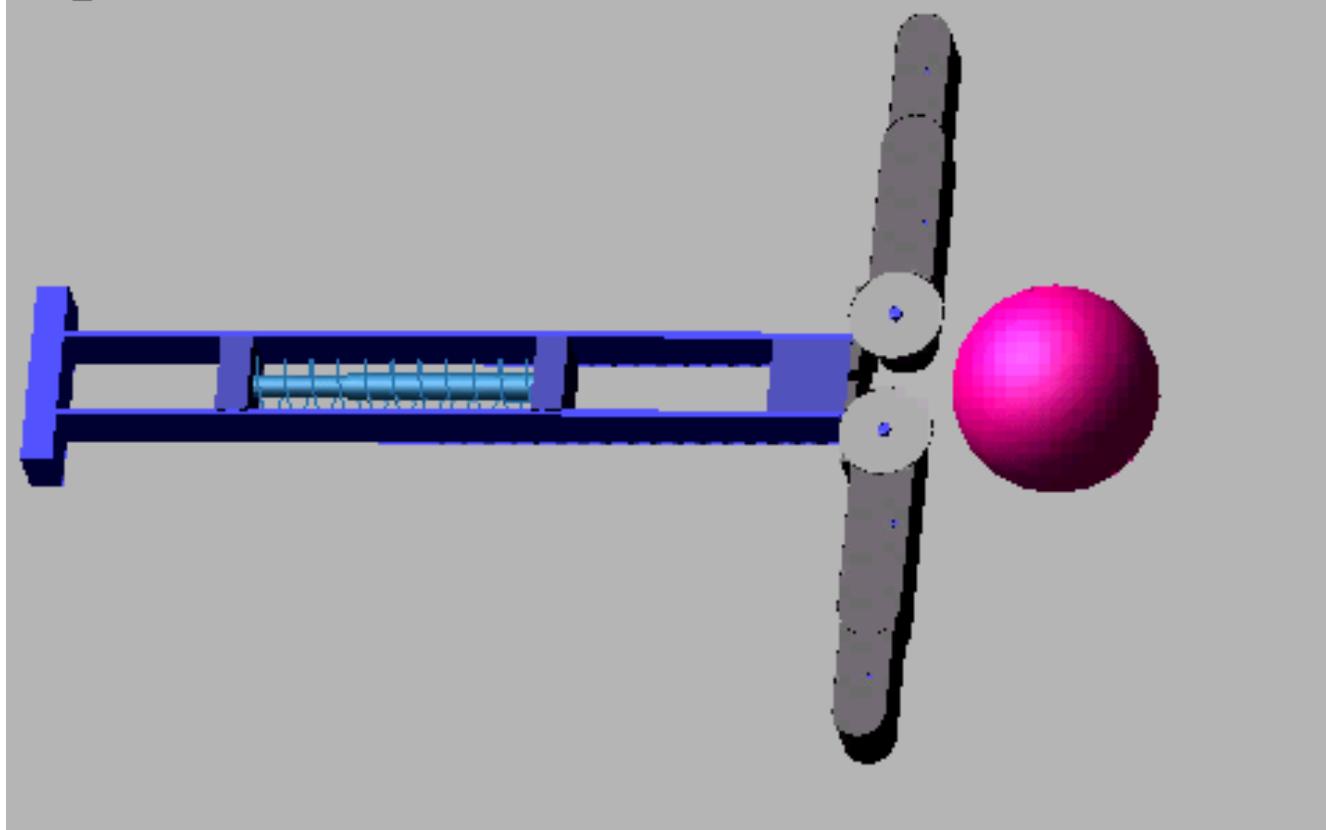
ハンドの運動エネルギー

シミュレーション(失敗例)

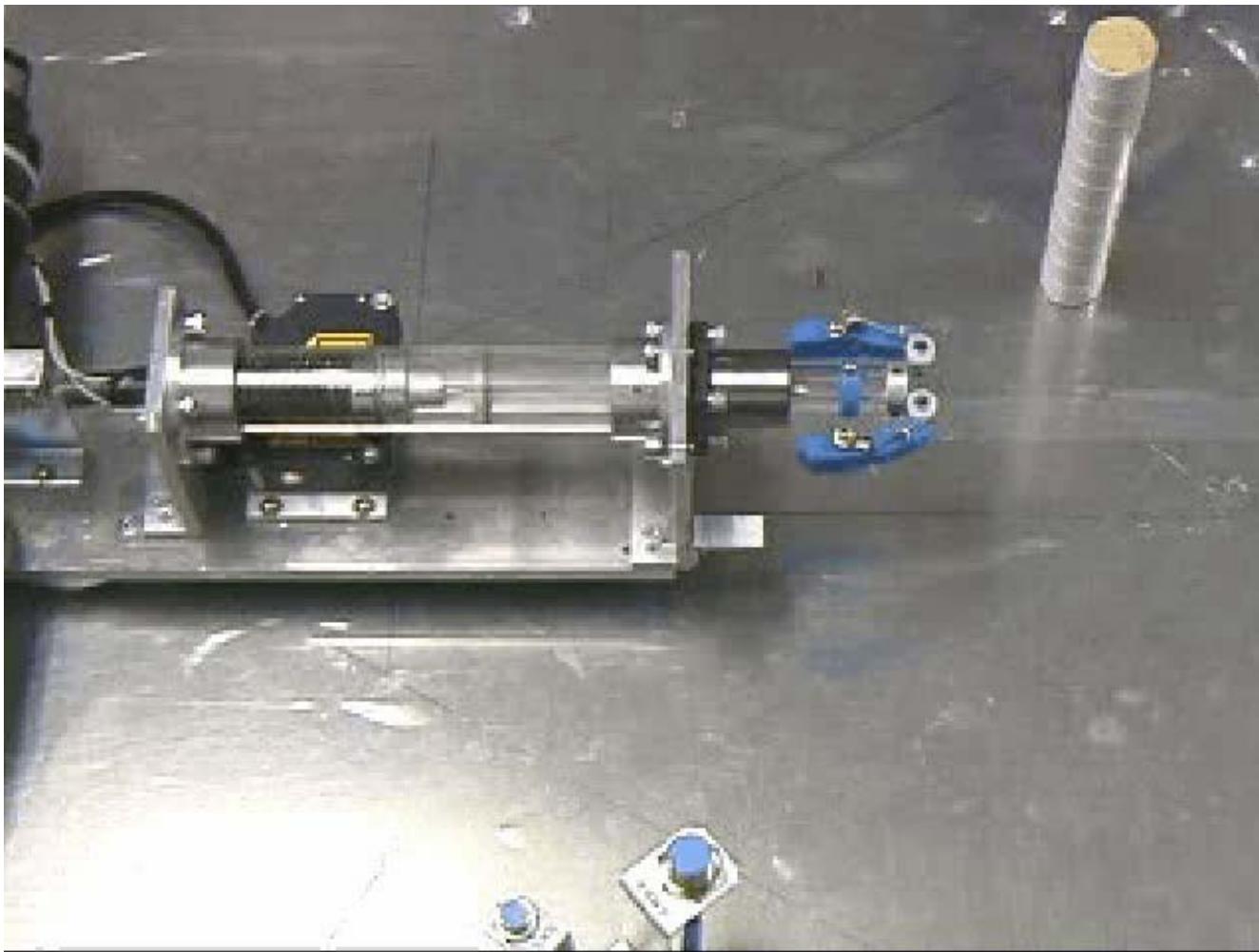


シミュレーション(成功例)

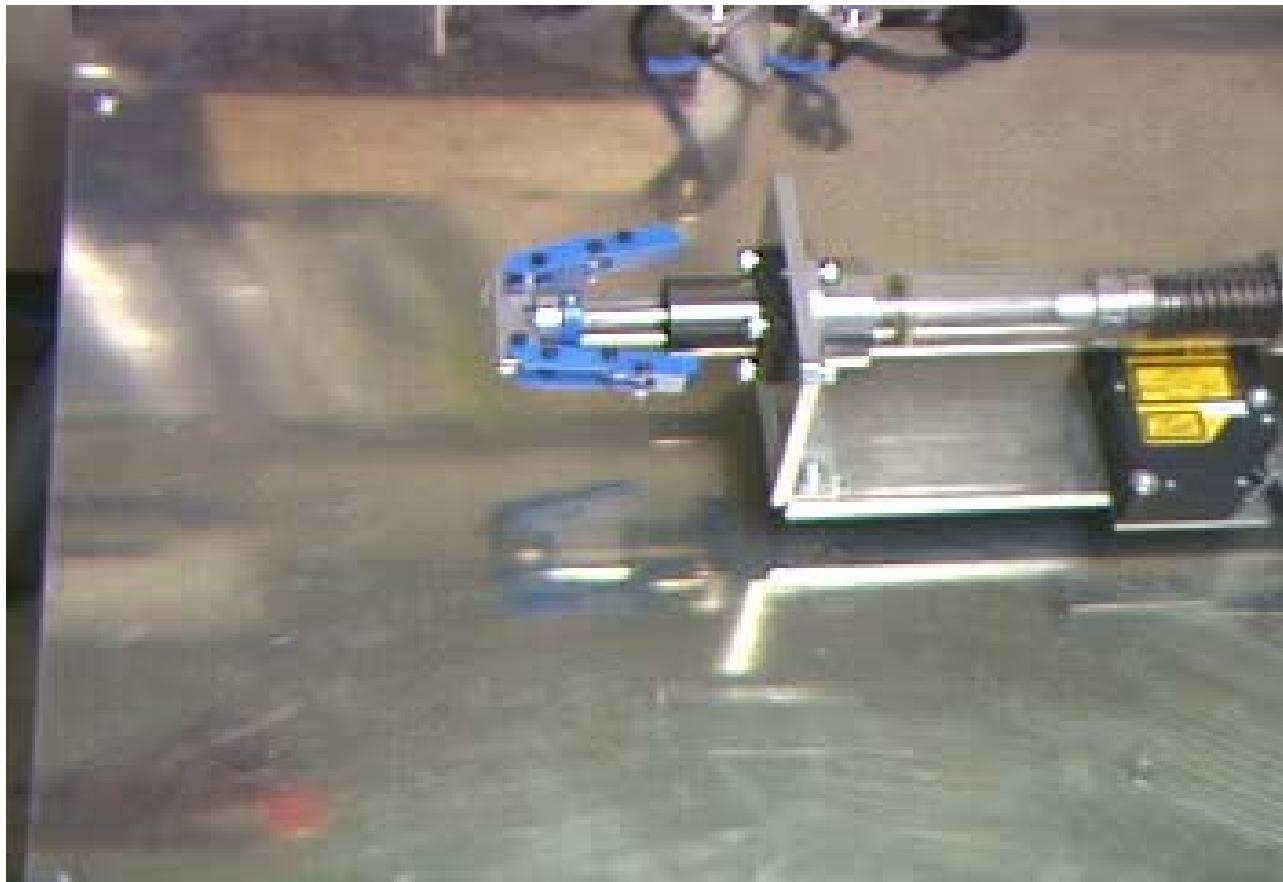
Last_Run Time= 0.0000 Frame=1



100Gロボット(prototype)



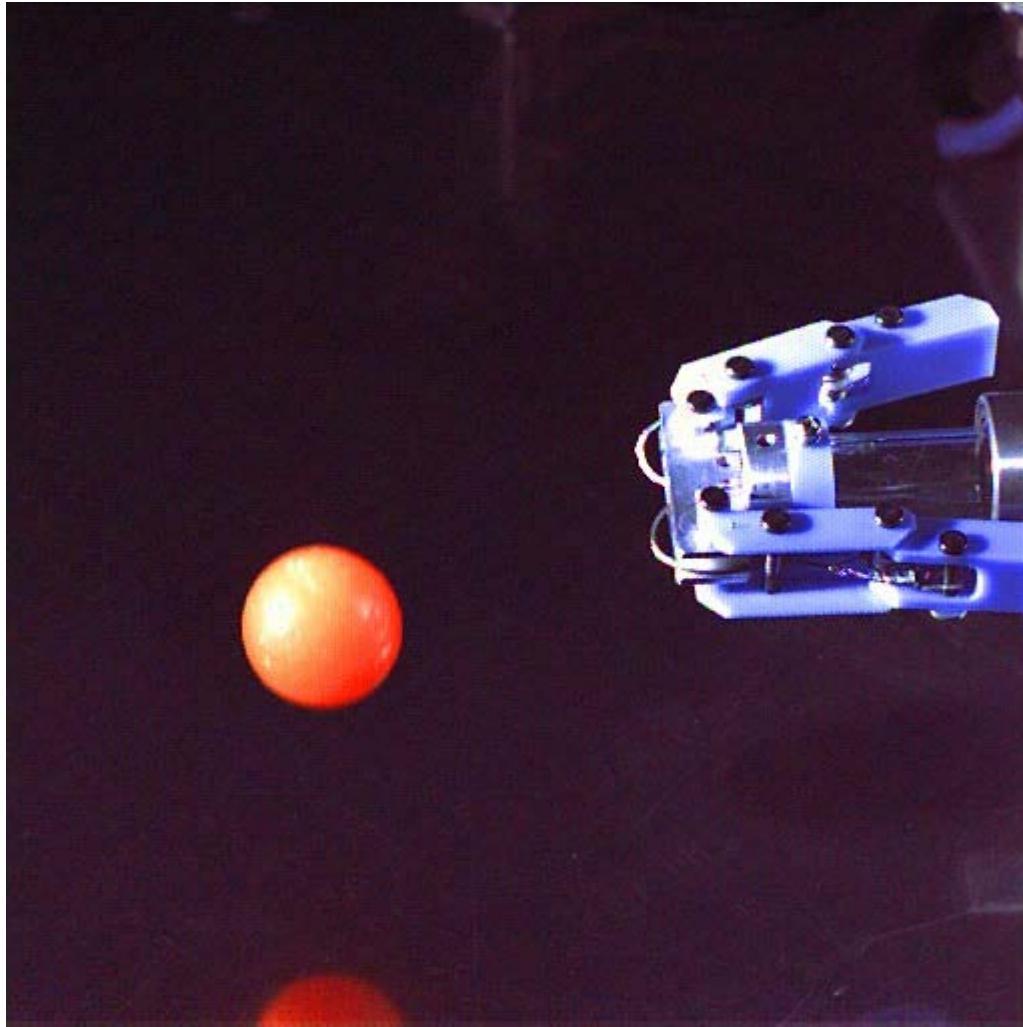
ボールの捕獲実験



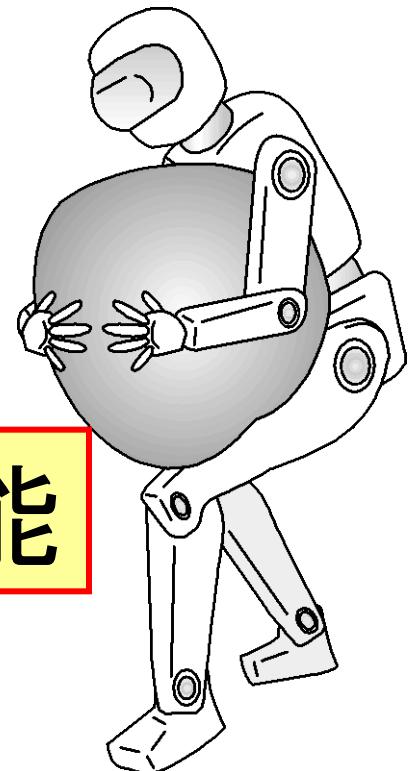
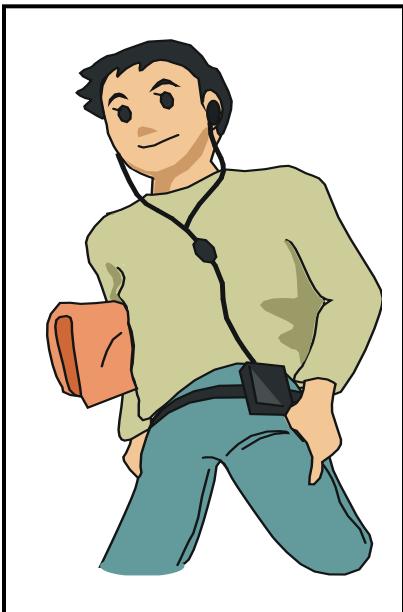
100Gロボット(第二バージョン)



高速カメラによる捕獲動作の再現

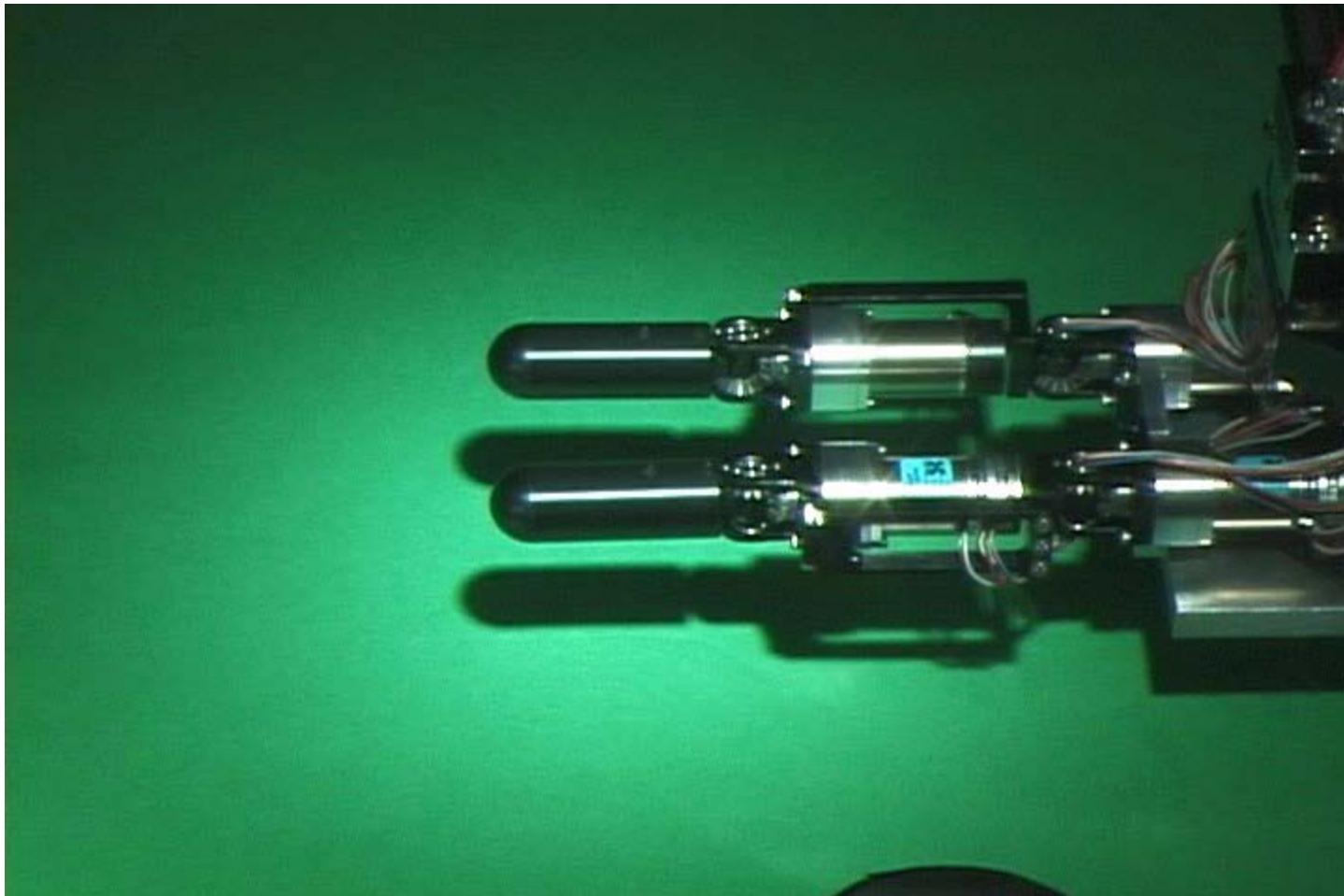


Beyond Human



特化した機能

高速2指ハンド

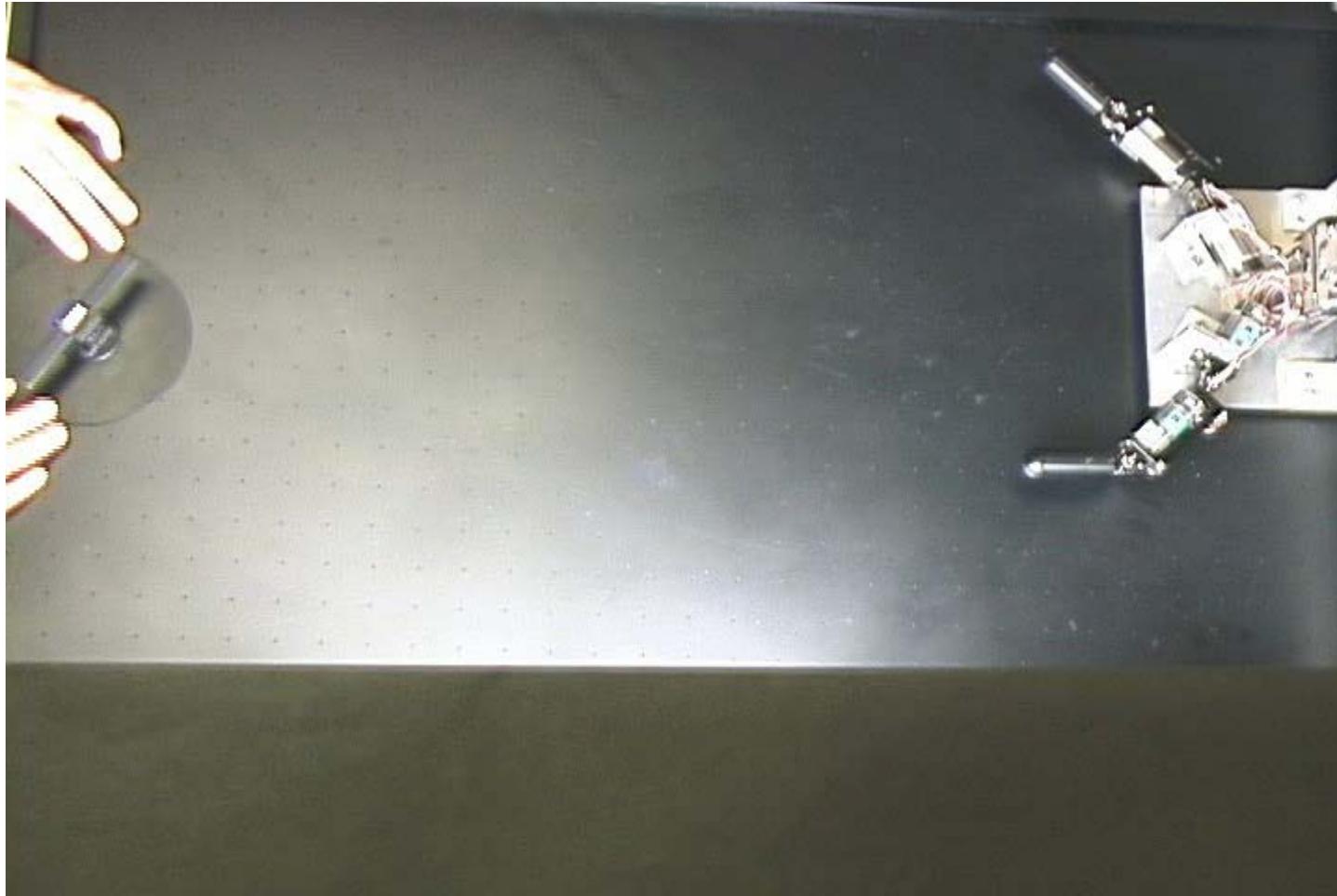


Higashimori, Kimura, and Kaneko (2003)

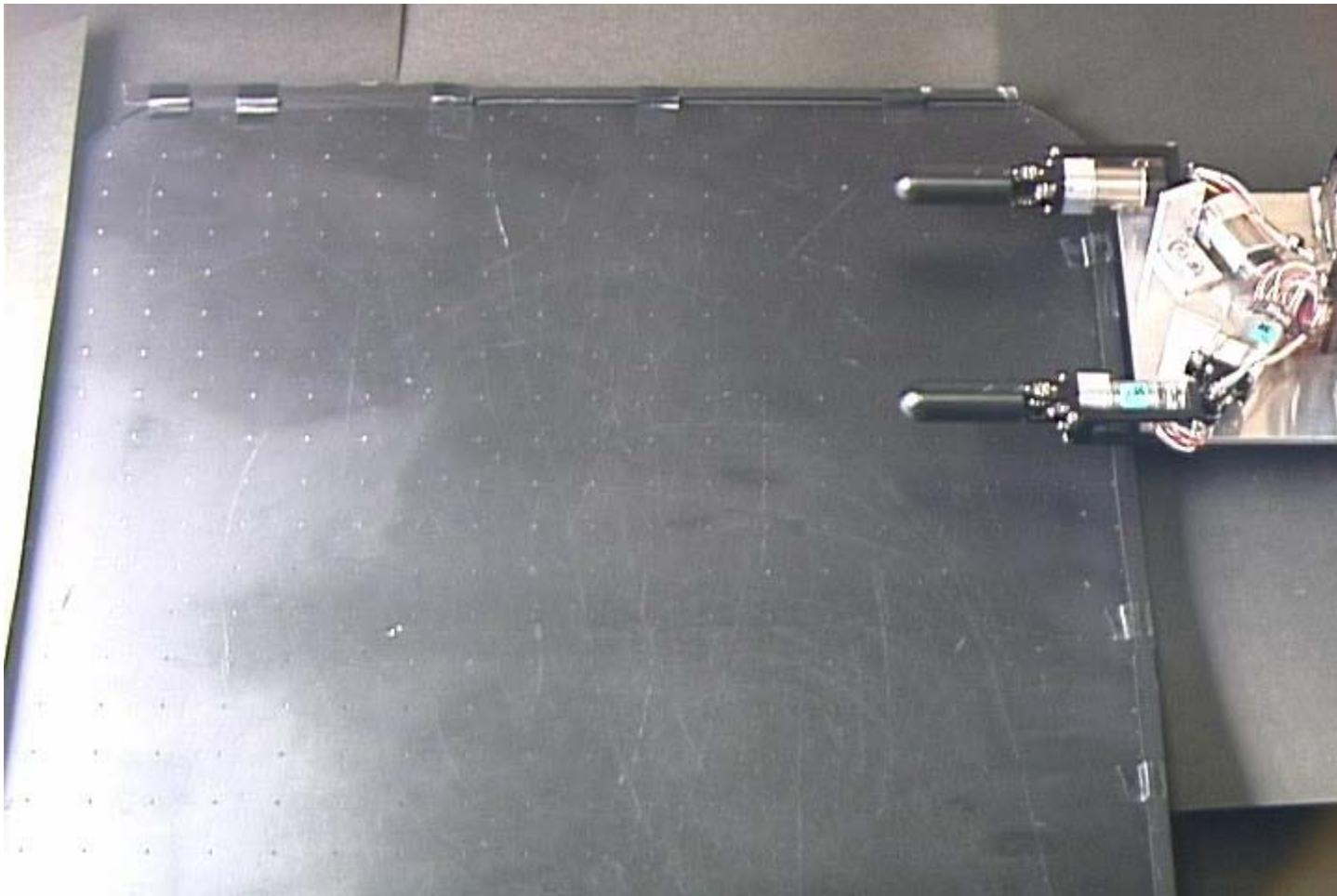
回転止め



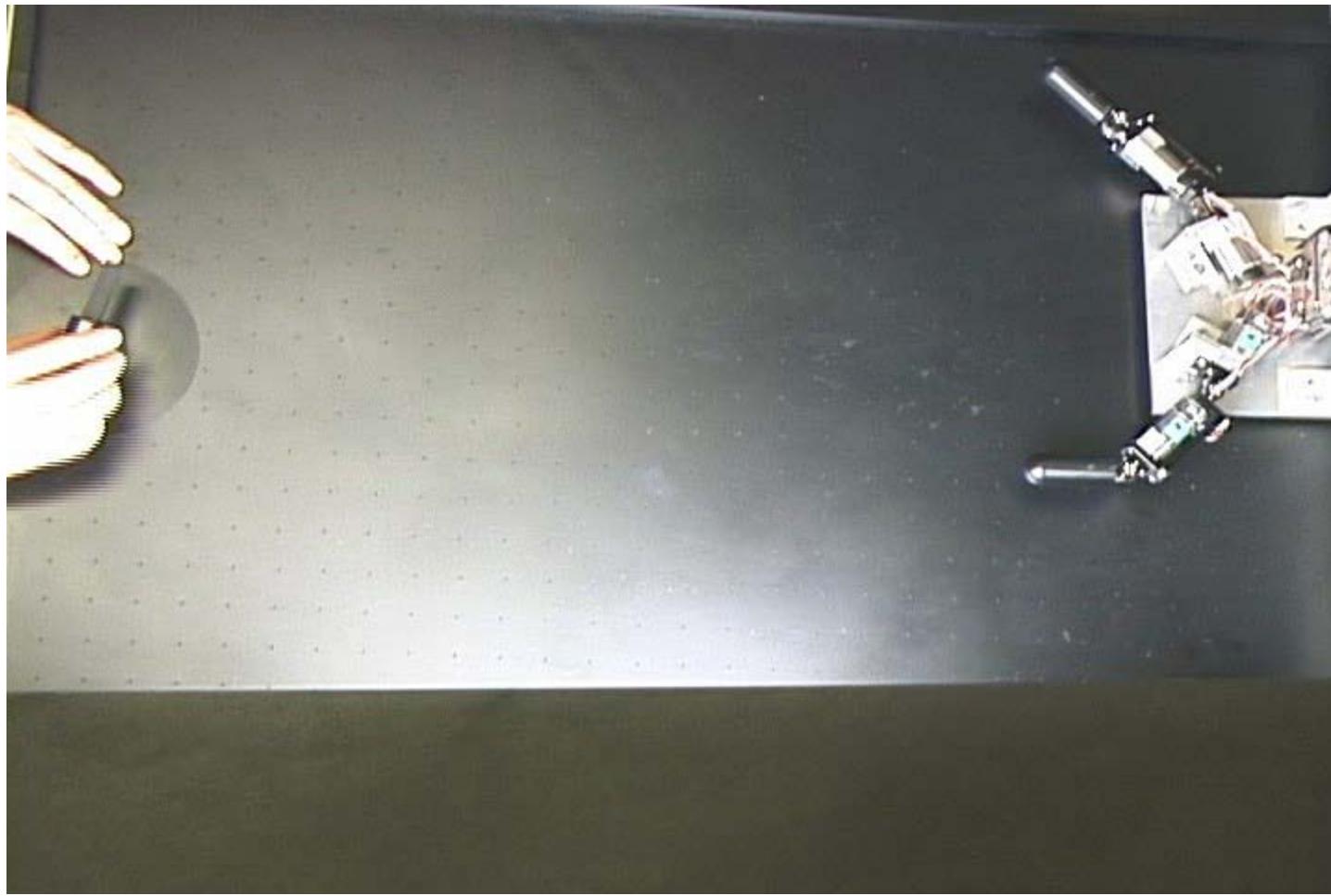
並進止め



捕獲実験その1



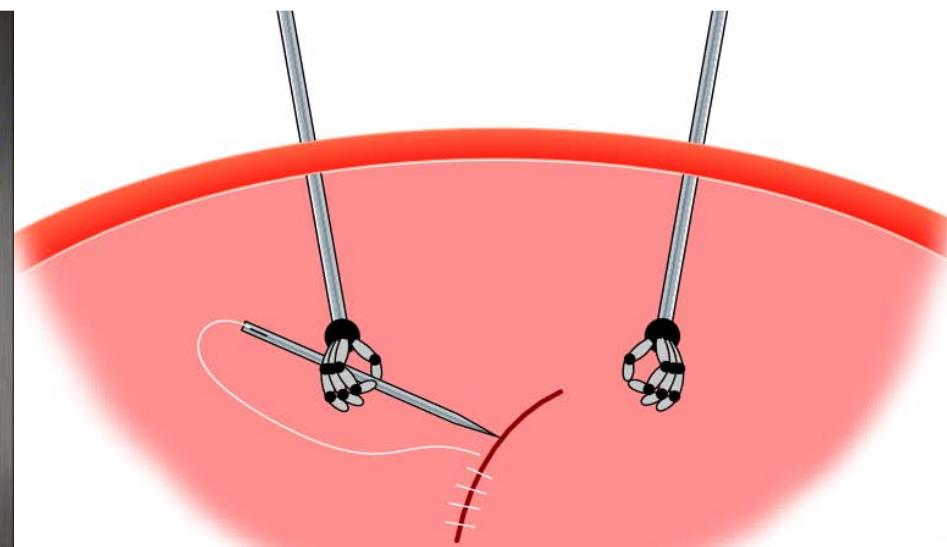
捕獲実験その2



Biomimetic Approach

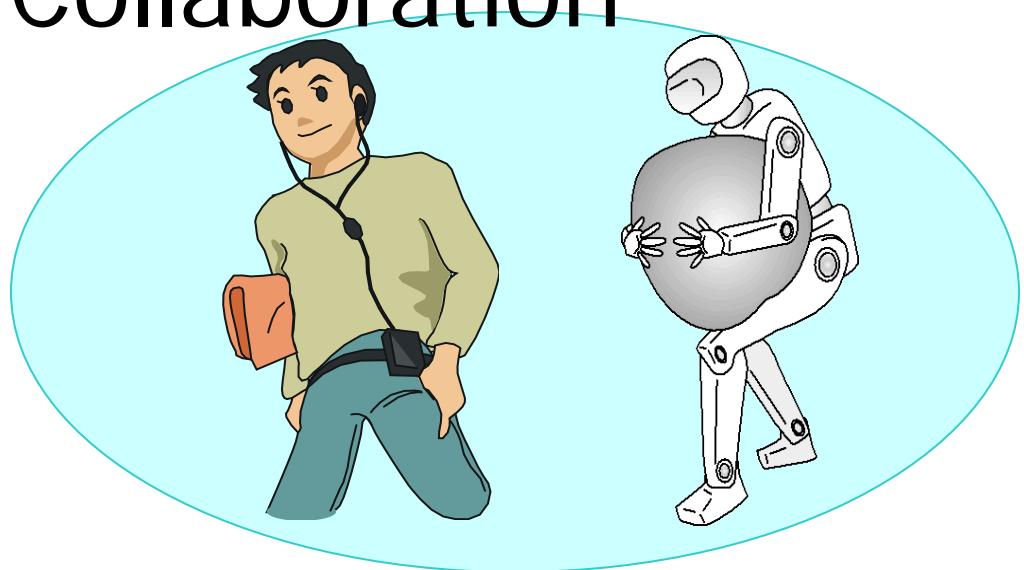


The goal is to develop a robot system beyond Human!!



Future Direction.....?

Human Robot Collaboration



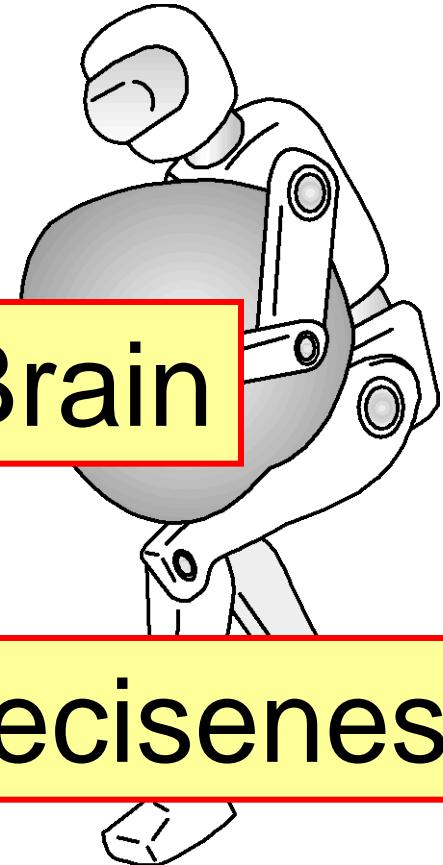
How to Collaborate?



Dexterity, Brain



Speed, Preciseness

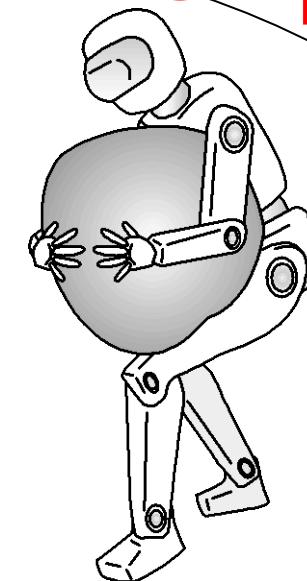


Human/Robot Collaboration

Extension of Human Capability



Dexterity, Brain



Speed,
Preciseness

Gripper Design

Multi-jointed hand is not implemented into da Vinci.

