# Adaptive Control of a Robotic Manipulator

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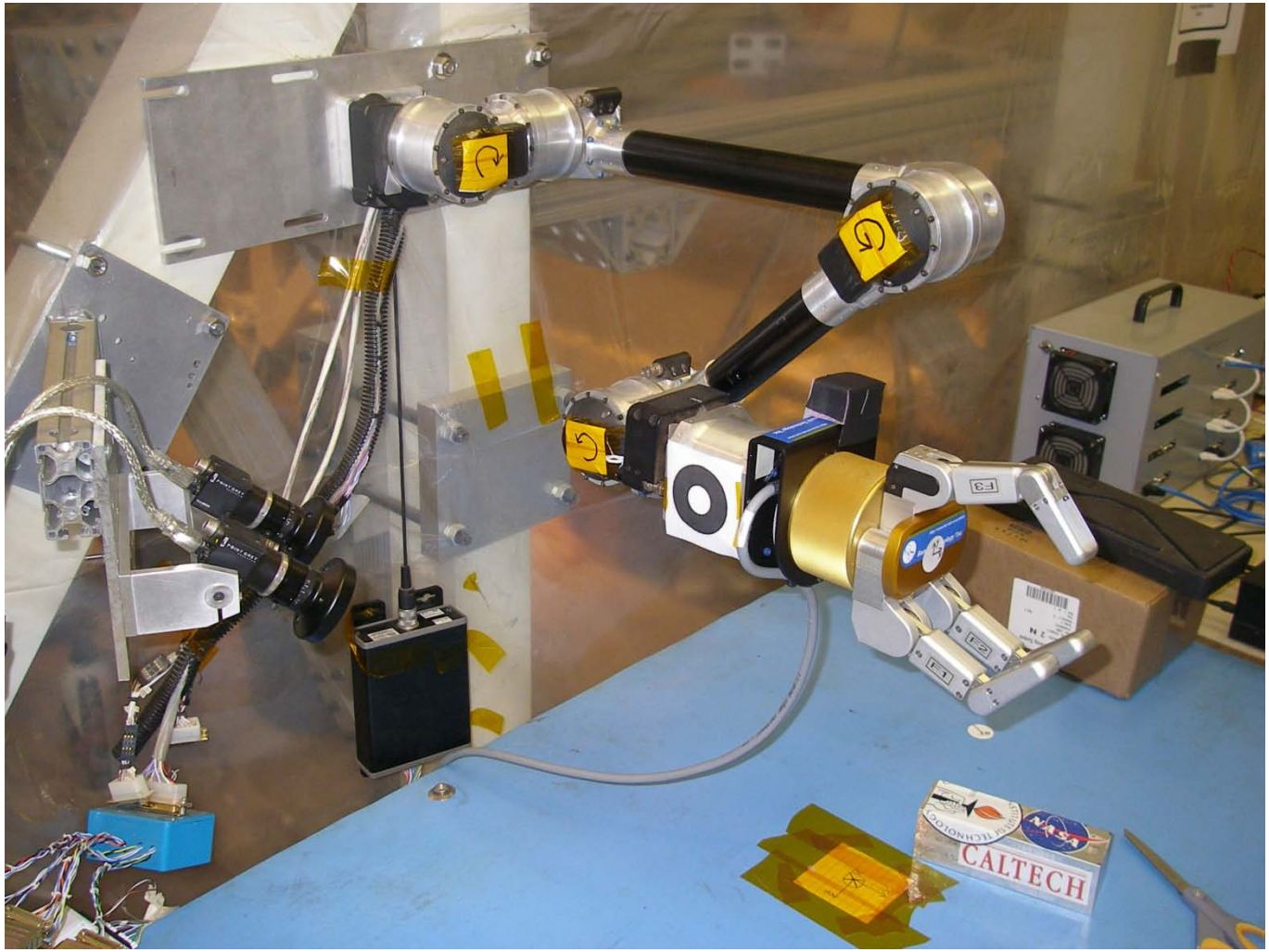
# Outline

- Background
- Results
- Modules:
  - Grasper
  - Adaptive modeling
  - GCM
- Challenges
- Further work

# Background



# Background

- My job: build infrastructure to implement adaptive force control
- Previous lab work:
  - Robotic arm attached to Pluto rover
    - Code for arm kinematics, FTS, vision
  - Hand tuned force control for drilling/coring
- Goals:
  - Grasping & manipulation routine
  - Writing with a pen using adaptive force control
  - Open lock with grasped key

# Results: Grasping

# Results: Force Control

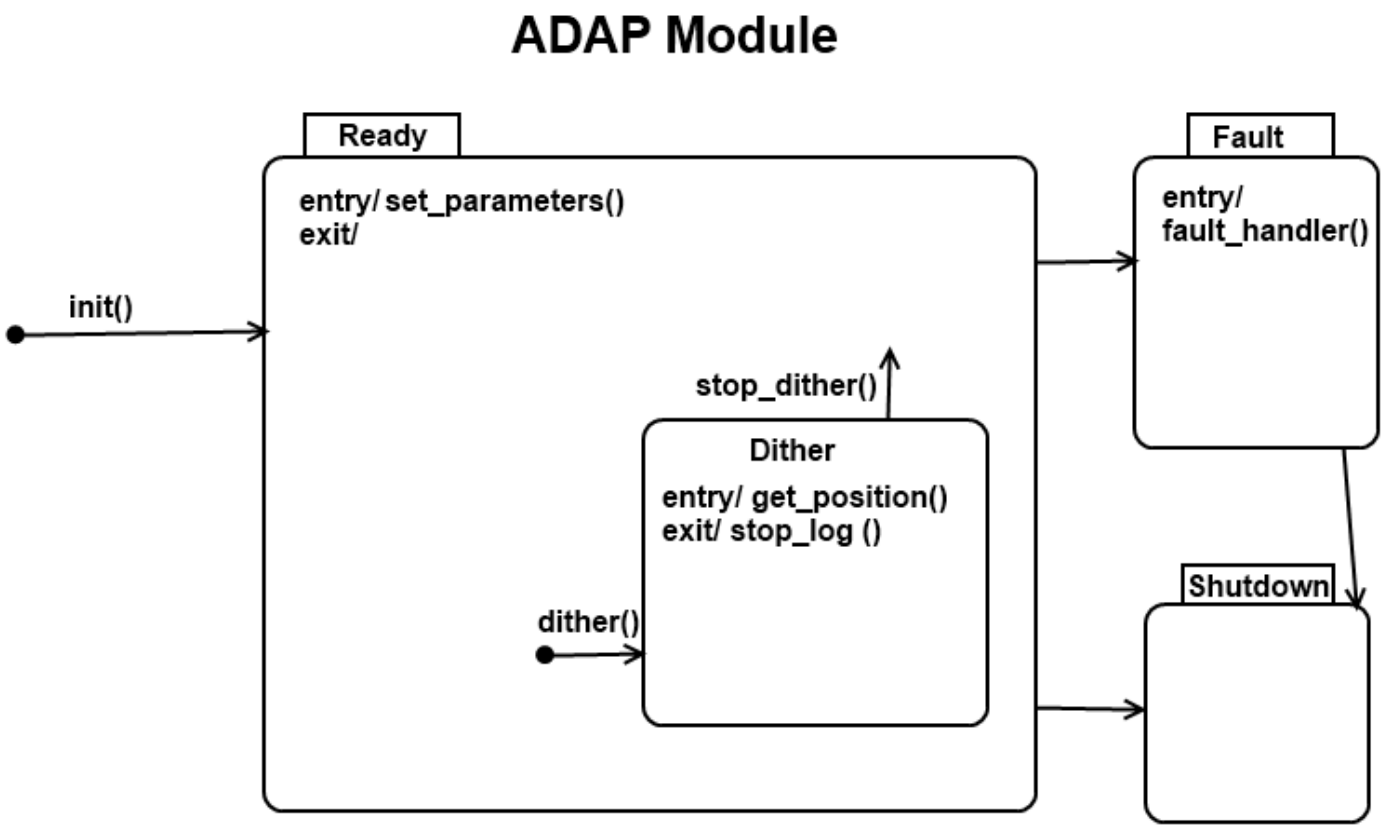
# Results: Disturbances

# Results: Writing on a slope

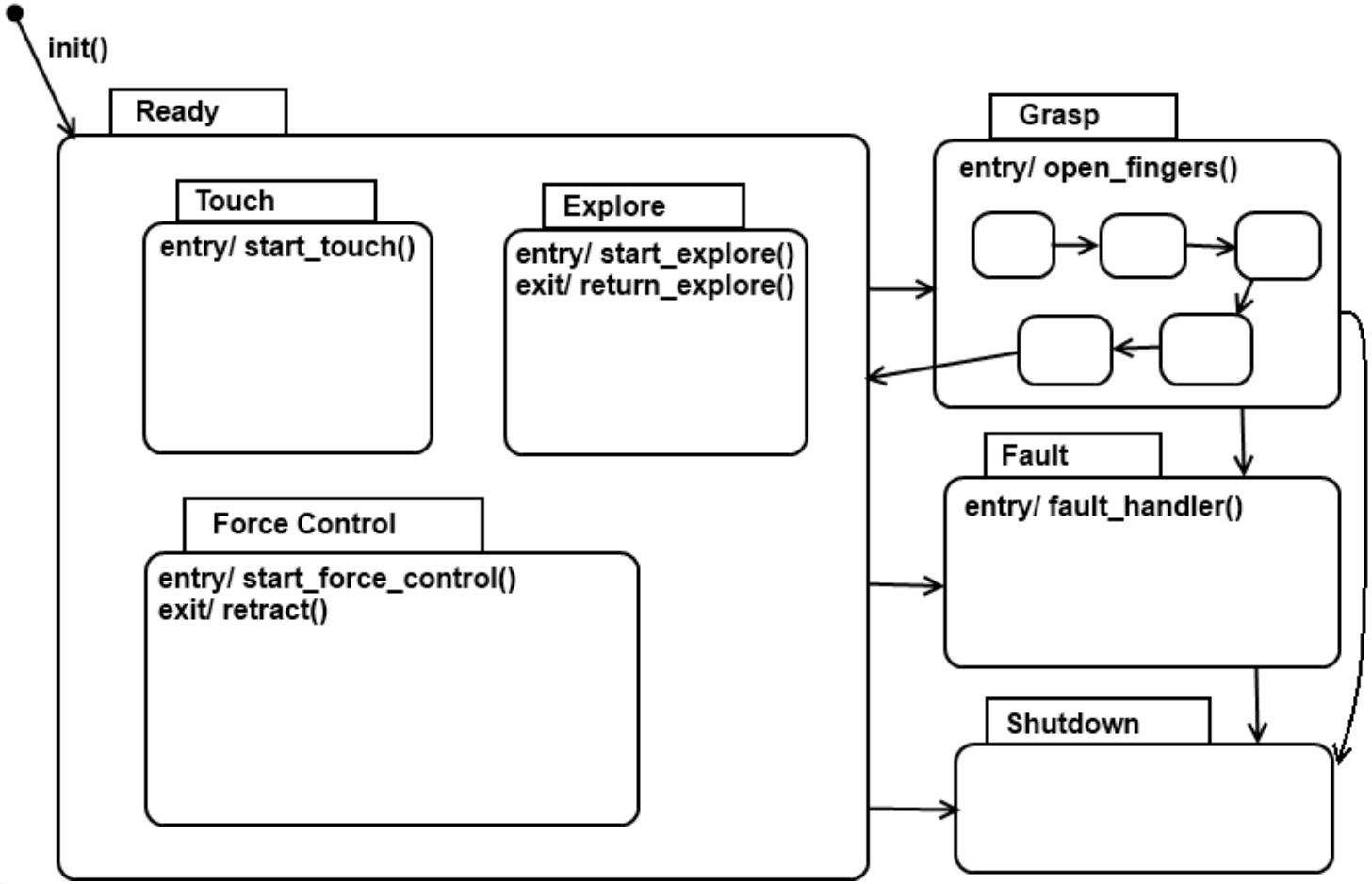
# Grasper

- BarrettHand™ model
- 4 degrees of freedom:
  - 3 fingers
  - 1 spread
- Wrote grasper module

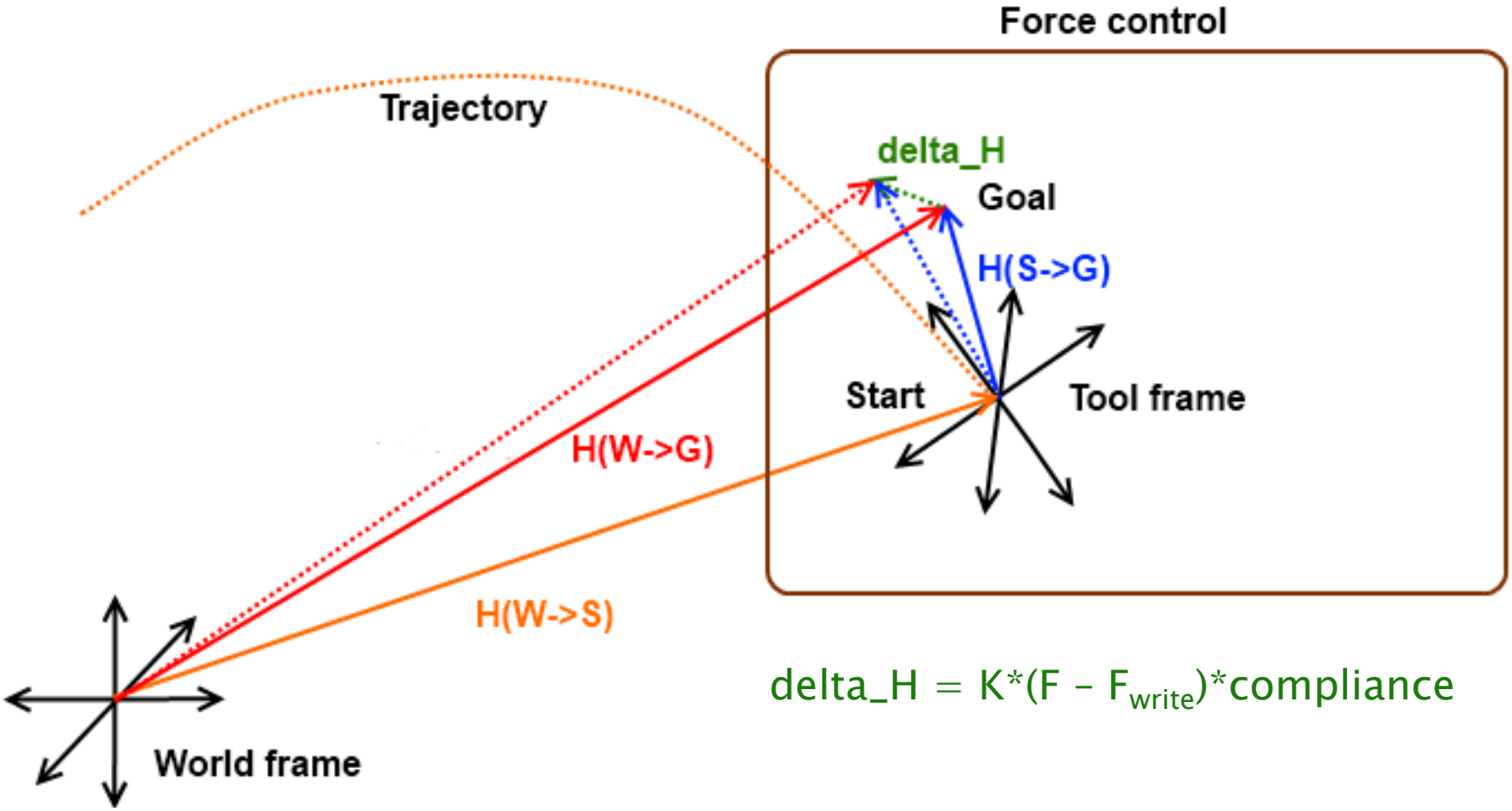
# ADAP: Adaptive modeling



# GCM: Generalized Compliant Motion



# Force Control Algorithm




$delta\_H = K*(F - F_{write})*compliance$

# Challenges

- Arm stiffness: makes adaptive modeling hard
  - Solutions: grasper, new arm
- FTS lag-> noise, operates at only 10Hz
  - With Butterworth filter, high settle time
  - Solution: faster FTS
- Current limits on joint motors
  - Heavy grasper, objects
  - Solution: new motors, new arm
- 5 DOF arm
  - Can't reach arbitrary 6 DOF pose
  - Inverse kinematics code constrains tool coordinate frames

# Further work

- Install new FTS
  - Operate at higher frequency
- Modify ADAP to output 6 DOF stiffness
- Future task: open lock with key
  - Requires balance of force + position control on all DOF

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