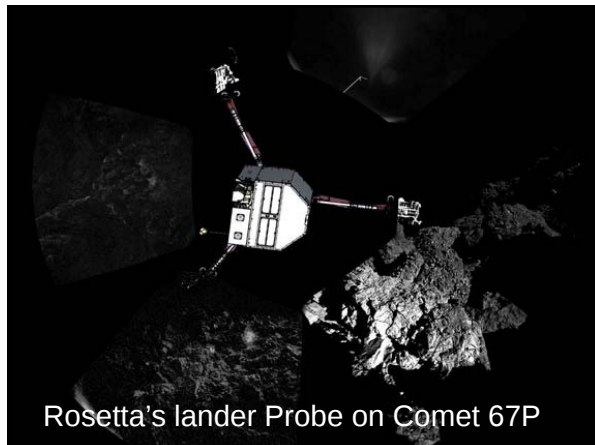


Working with robots



Robotics New Frontiers



Underground - Mining



Underwater Archeology



Mission Lune
Photo Frédéric Osada - Teddy Seguin
Direction Michel L'Hour (DRASSM)

Coral Reefs



Underwater Pipeline Inspection and Maintenance



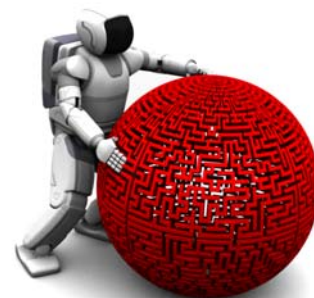
Underwater Vehicles



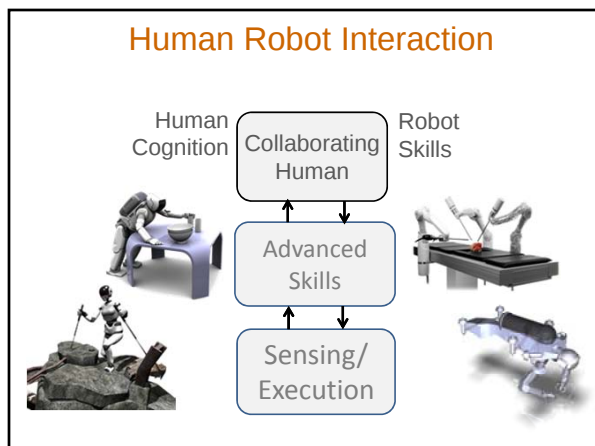
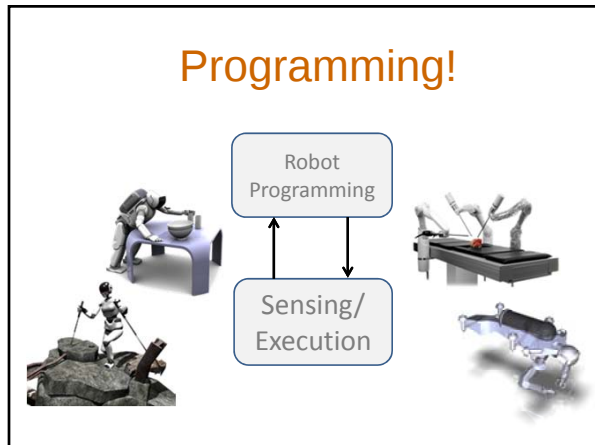
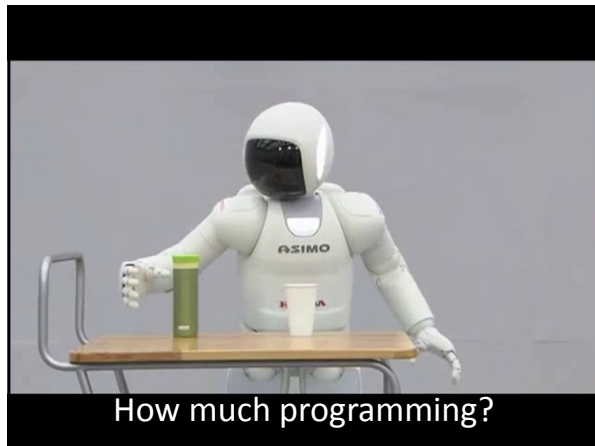
Disaster Environments



The Challenge:
beyond mobility



.. not only walk, but also interact with the world!



human-robot synergy

human-robot direct interaction



Romeo and Juliet: Human Guided Motion



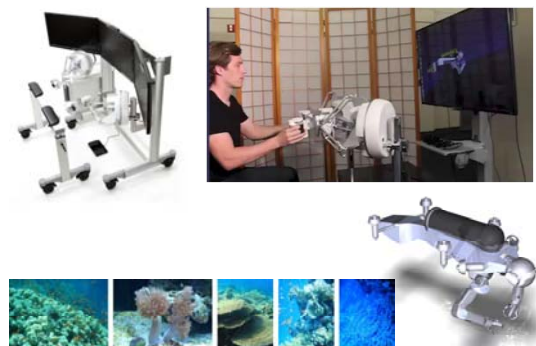
Compliant Motion Primitives

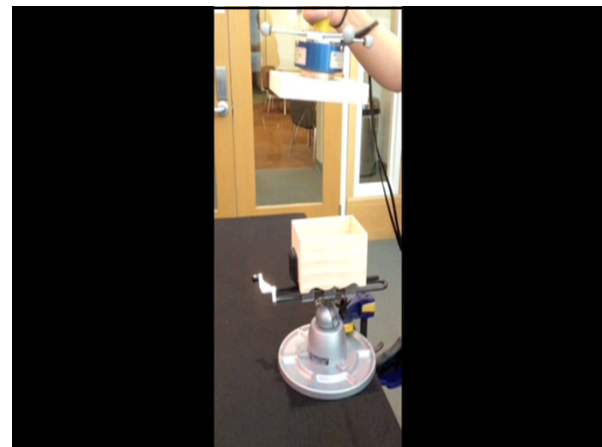
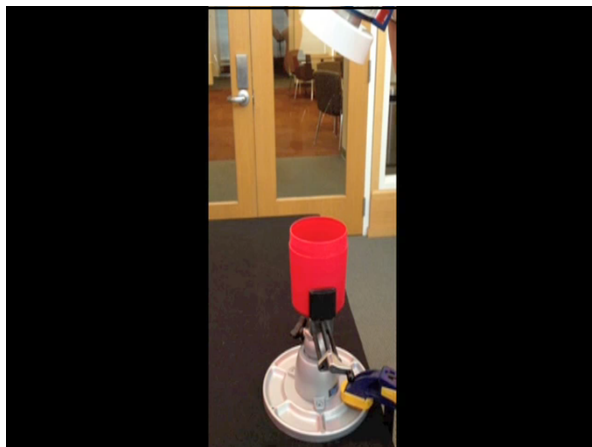
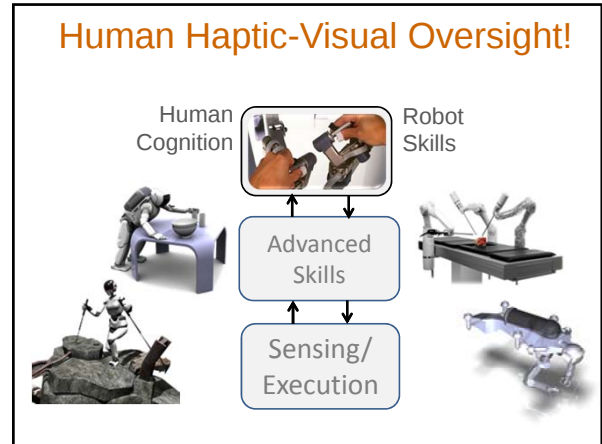
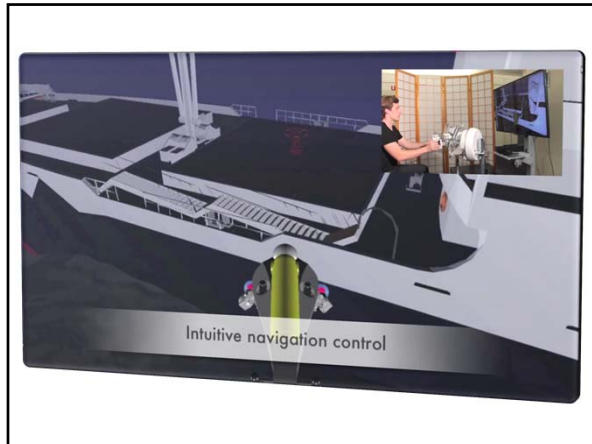
haptic mediation

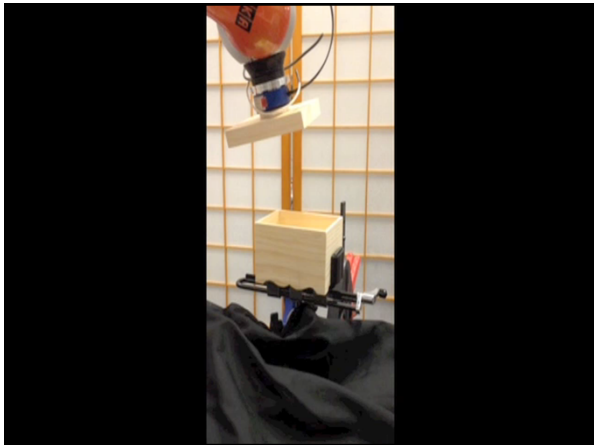
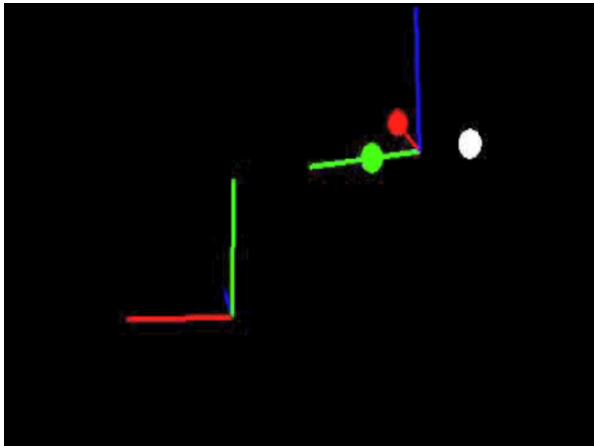
Haptics-Communication-Robotics



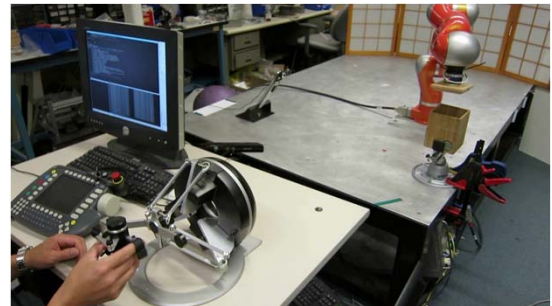
Human Cognition & Robot Skills







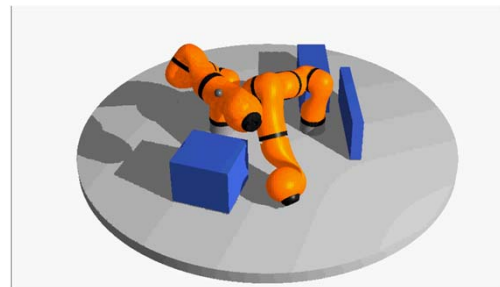
Haptic Interface



Haptic Interface



SAI: multi-contact simulation



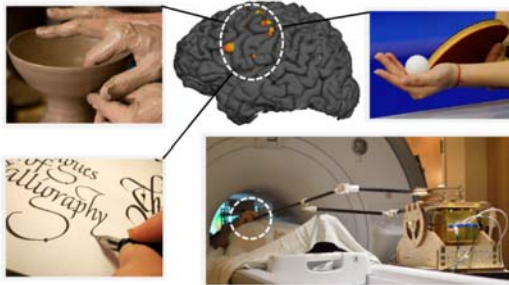
Understanding Human Motor Coordination

fMRI-compatible haptic device

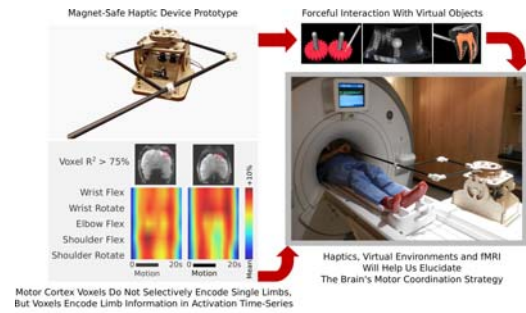


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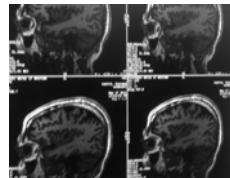
fMRI Motor Control Studies



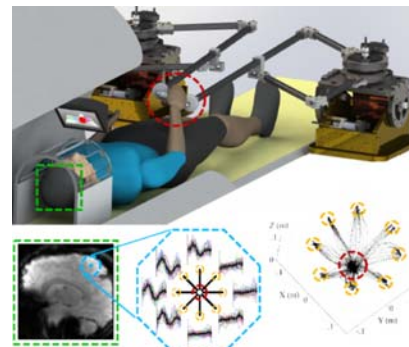
fMRI Motor Control Studies



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fMRI Motor Control Studies



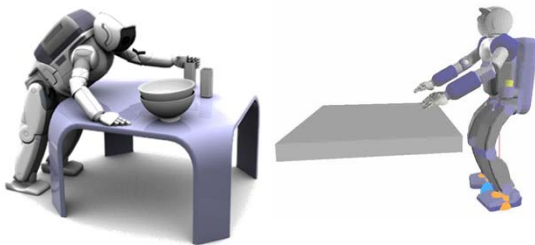
Multi-contact
Manipulation



Multi-Contact Whole Body Motion



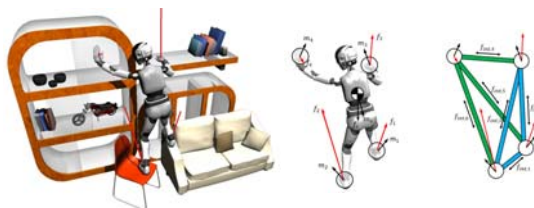
Physical Interaction, Constraints,
and Task Behaviors



Balanced Supporting Contacts
Internal Force Control – Virtual Linkage



Balanced Supporting Contacts
Internal Force Control – Virtual Linkage



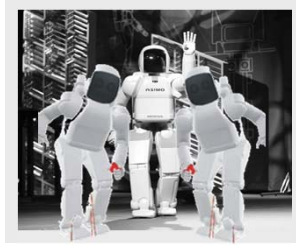
Physical Interaction, Constraints,
and Task Behaviors



Posture
Task Behavior
Multiple Contacts
Internal Constraints
Self Collision
Local Obstacles
Balance

Unified Whole-Body Control Framework

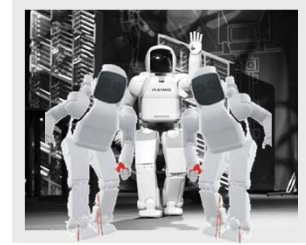
posture
consistent with {
 Task
consistent with {
 contact
consistent with {
 internal constraints
 self collision
 local obstacles
consistent with {
 balance
 } } }



interact with the world,
 cooperate, and manipulate

Constraint-Consistent Task-Space

$$v_{\otimes} \in cc - space$$



interact with the world,
 cooperate, and manipulate

Unified Whole Body Control Framework

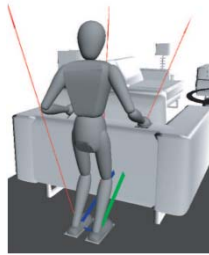
Task, Posture, Constraints, Multiple Contacts, and Balance

Dynamics

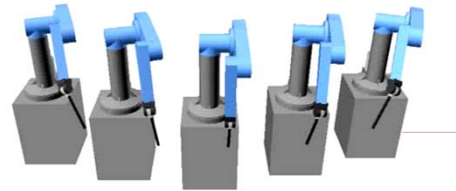
$$\Lambda_{\otimes} \dot{\hat{q}}_{\otimes} + \mu_{\otimes} + p_{\otimes} + F_f = F_{\otimes}$$

Control

$$F_{\otimes} = \hat{\Lambda}_{\otimes} F_{\otimes}^* + \hat{\mu}_{\otimes} + \hat{p}_{\otimes}$$

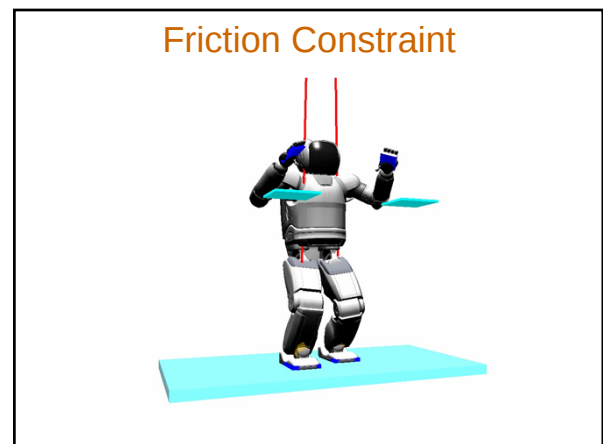
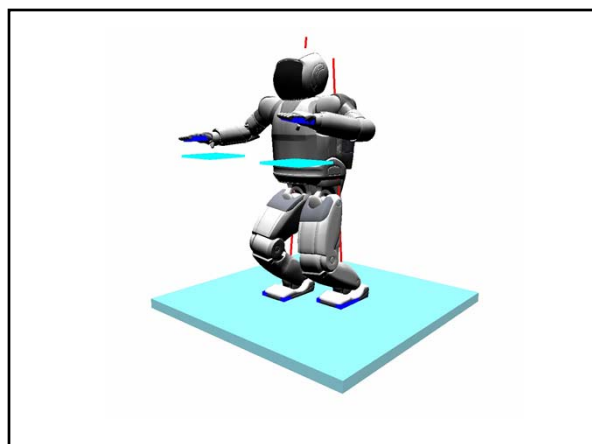
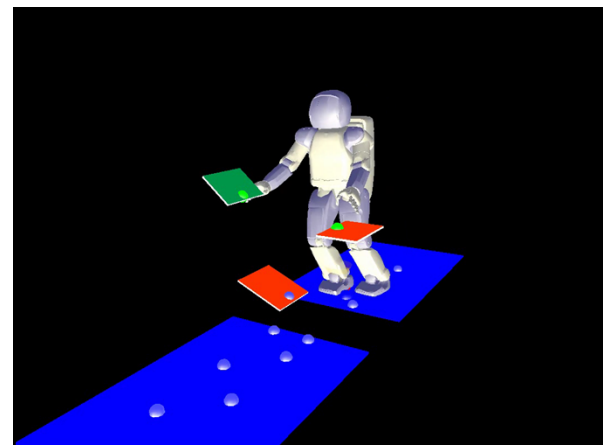
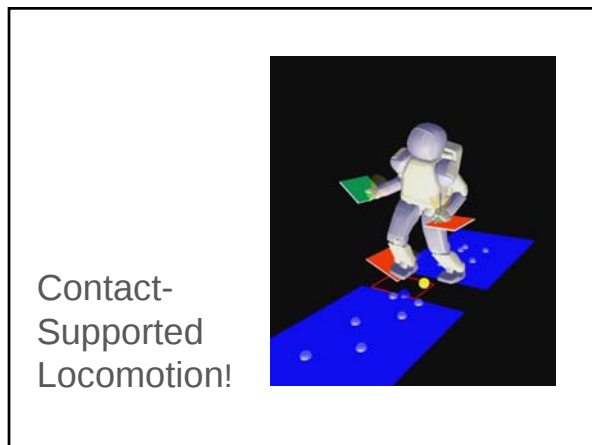
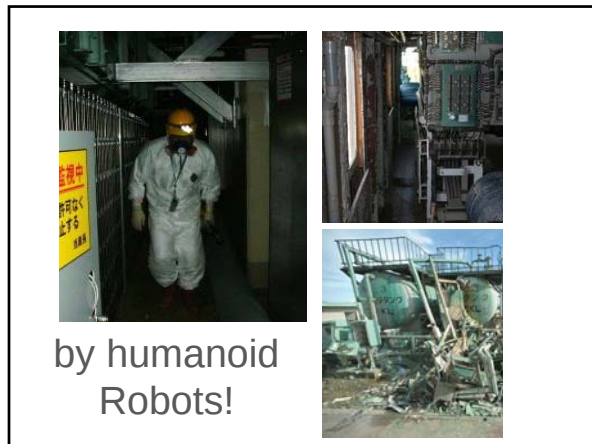


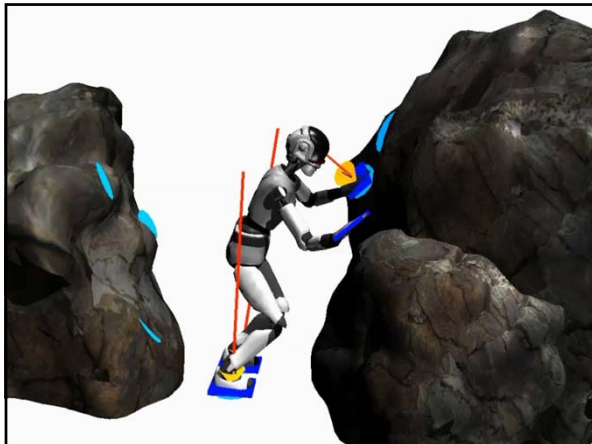
Elastic Planning



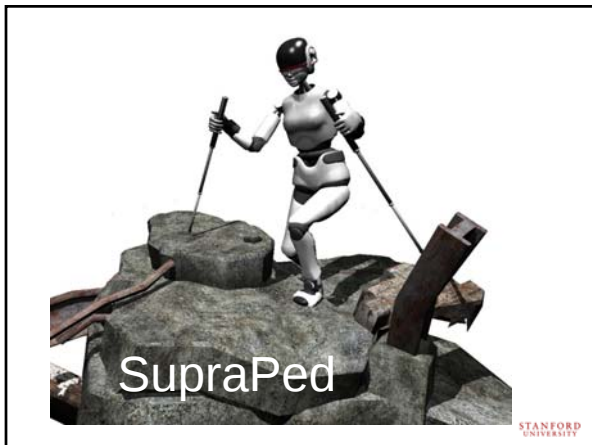
Disaster
 And
 Dangerous
 Areas



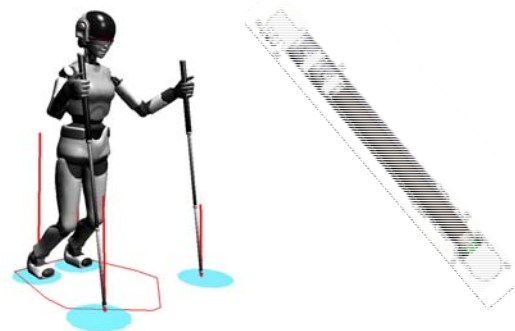




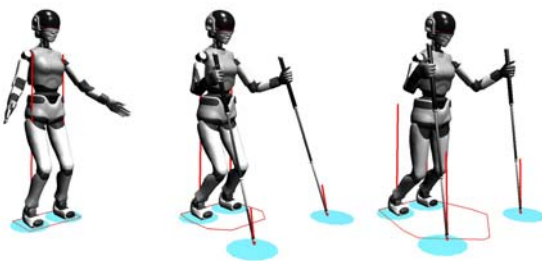
Manipulation/Balance



Smart Supporting Pole

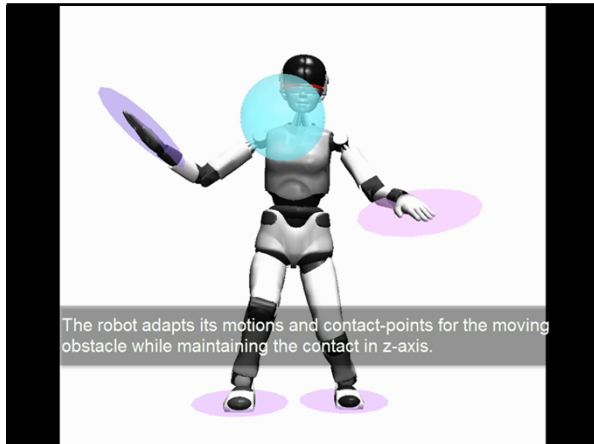


SupraPed



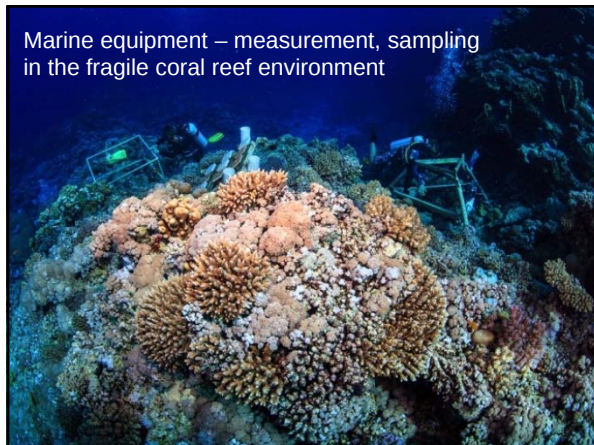
Large Increase of Support Area



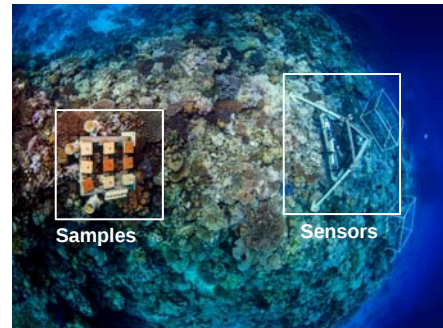


Red Sea Robotics Exploratorium

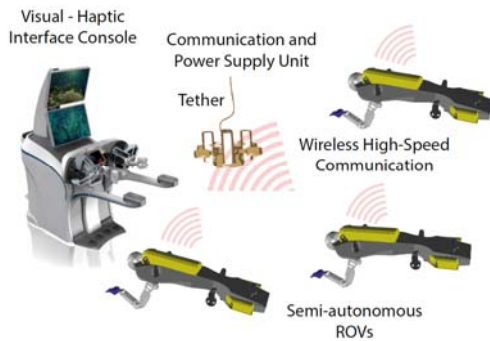
Stanford, Meka, KAUST



Coral Reef Monitoring

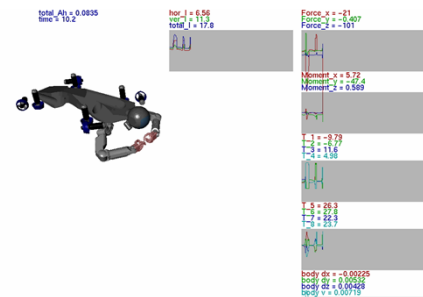


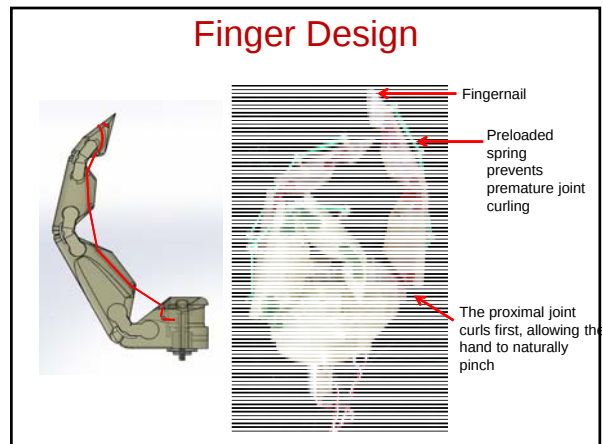
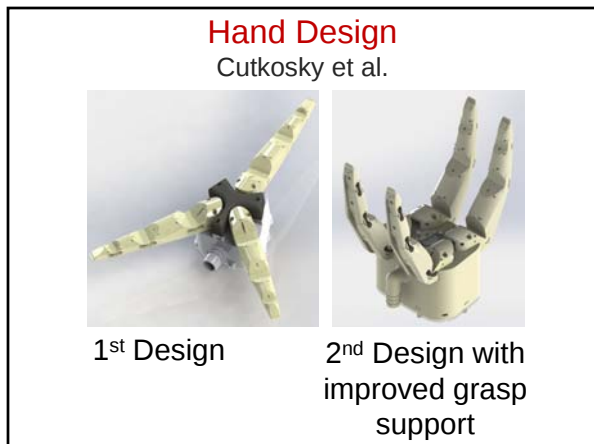
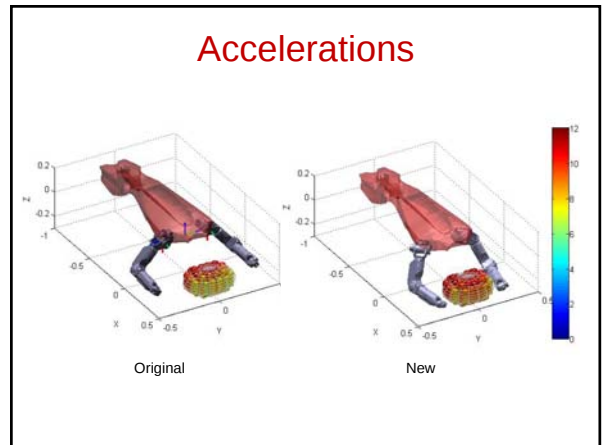
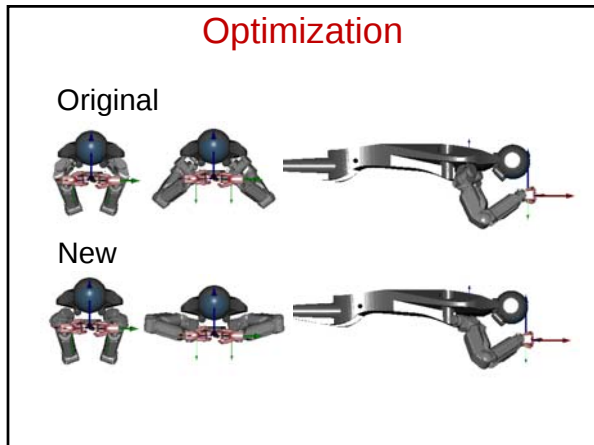
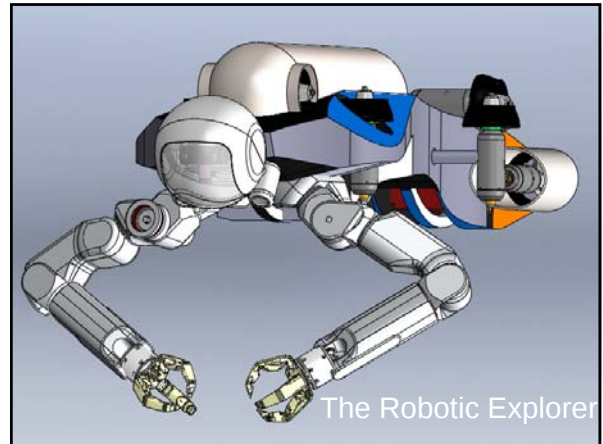
Autonomy and Communication



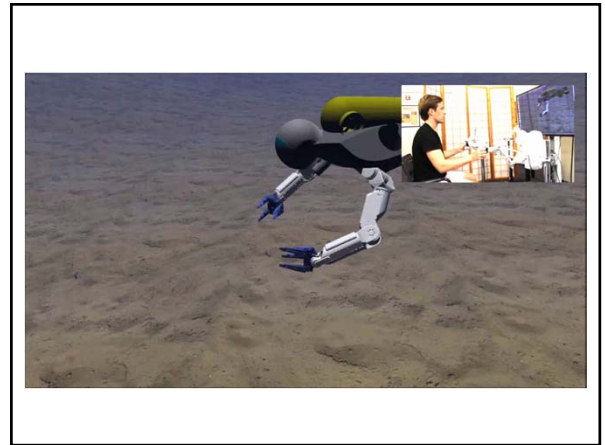
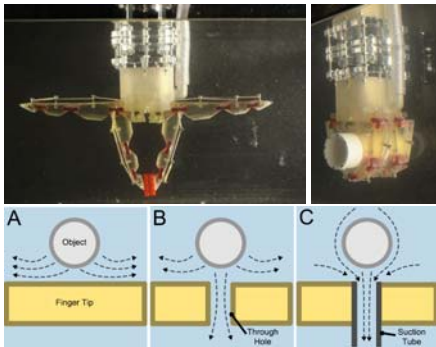
Design optimization

macro-mini dynamics coordination





Finger Suction



Ocean One, O2,
The Robotic Explorer

