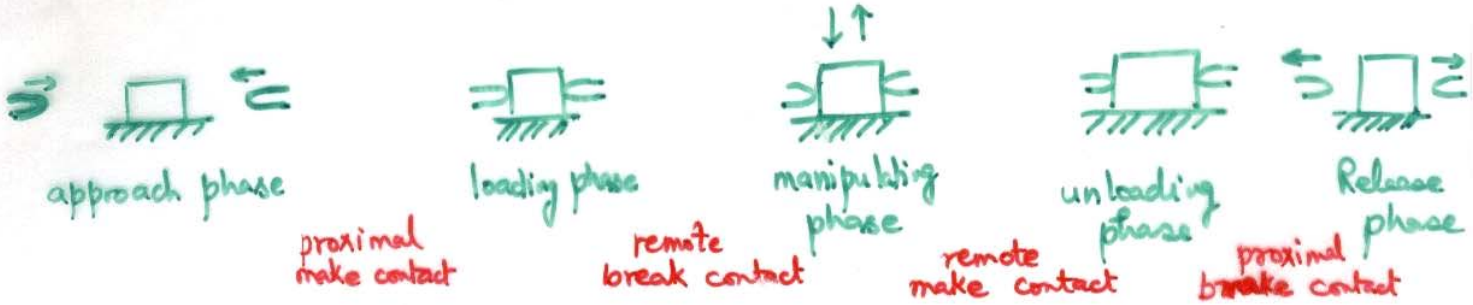
High level control for dextrous manipulation (Ricker, Sarkar, Rudie IEEE RA, Nov. 1996)

- Grasp. lift. replace task (example of dextrous manipulation)

Task conducted for experminentally determining parameters such as coefficient of friction



- 5 "phases" separated by 4 "events"

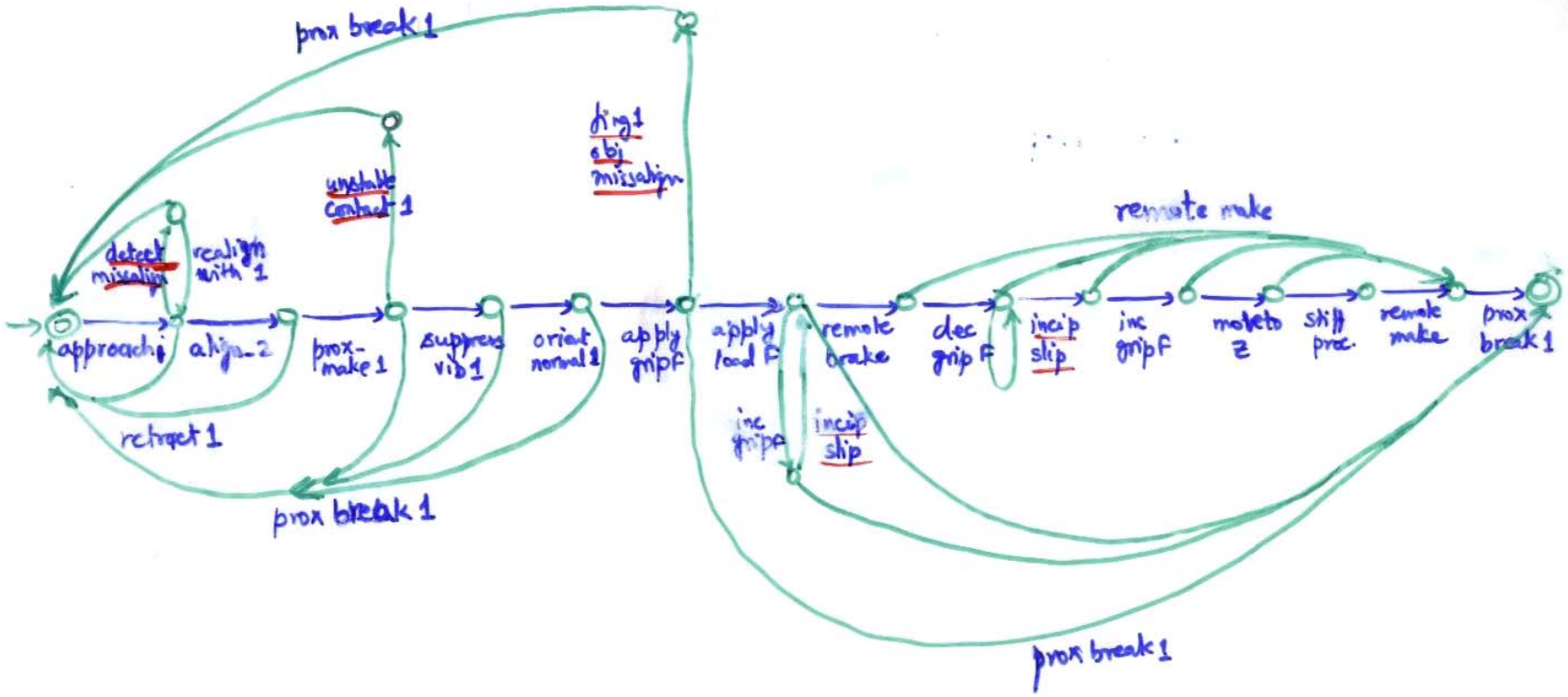
- assumptions:
  - object is block shaped
  - object location known
  - each finger equipped with two force sensors to measure grasp and lift, and a multi-element stress-rate sensor for sensing slip
  - slip is detectable from other vibrations
  - position sensor for fingertip location is also available

- When any slip is detected, grasp force is incrementally increased till object is successfully lifted

$W = 2\mu F_g = F_\ell$ $\Rightarrow$ weight W, friction coefficient μ can be found from forces F_g, F_ℓ.

$K = \frac{\Delta F_g}{\Delta a}$ determines stiffness as ratio of excess grasping force to deformation

Automata for finger 1



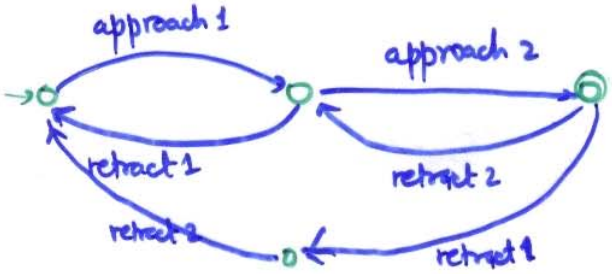
Plant := Finger1 || Finger2

DES model of each finger

DES model of specification

1. finger 1 approach before Finger 2
2. At most two attempts for finger alignment permitted
3. At most three attempts to make contact
4. At most two attempts to adjust grip force when slip detected

1



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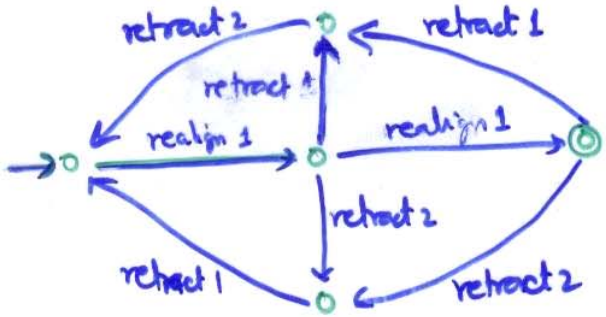

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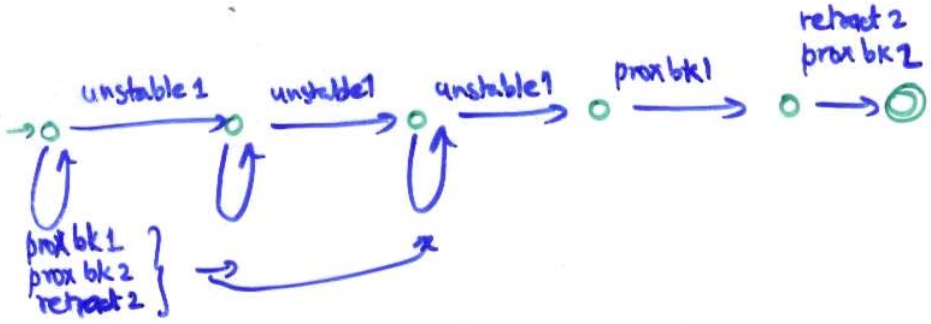

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