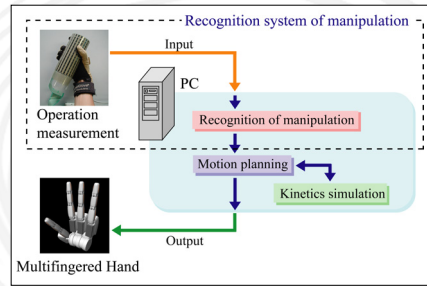


Manipulative Familiarization and Fatigue Evaluation Using Contact State Transition

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Robotics Laboratory

Direct teaching system



Multifingered robot hand as a ubiquitous application
Instinctive input method Realization of easy control from afar

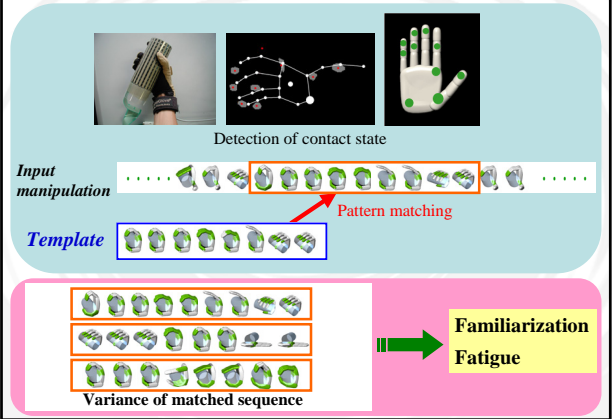
Recognition system for manipulation

Recognized by comparing template with input




- Conventional method
Familiarization and fatigue are not considered
- Proposed method
Familiarization and fatigue are estimated by variance for generating template

Outline of research



Operation measurement system



Nitta BIG-MAT

Polhemus

CyberGlove

Polhemus

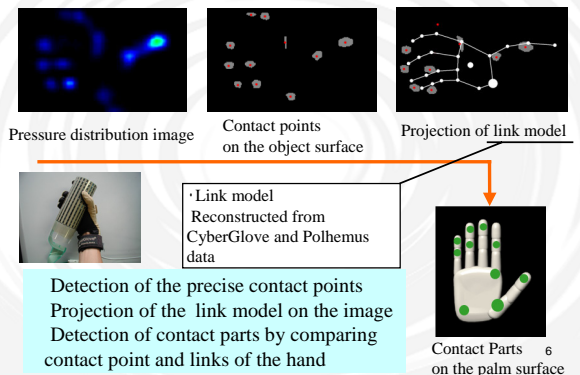
CyberGlove :
22 joint angle sensors

Polhemus (2 receivers) :
6DOF position/orientation sensor

Nitta BIG-MAT :
Pressure distribution sensor
Spatial resolution is 5 × 5 mm

- Sensors attached directly to the object
Detection of the precise contact points on the object surface / contact parts on the palm surface

Detection of contact information



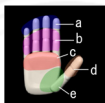
Detection of the precise contact points
Projection of the link model on the image
Detection of contact parts by comparing contact point and links of the hand

Contact Parts
on the palm surface

Recognition based on contact state transition on the palm surface

Manipulation is represented by the contact state transition

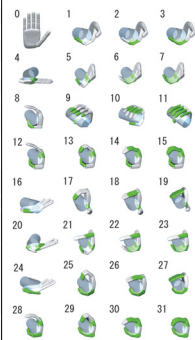
Divided into five parts



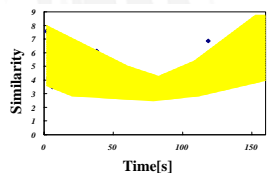
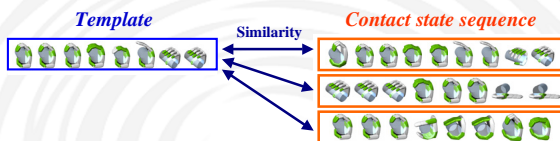
The continuous dynamic programming (DP) method is used for measuring similarity between template and input manipulation

Quantitative comparison of manipulation

All contact states



Estimation of familiarization and fatigue



Change in variance over time

Familiarization
Fatigue

8

Experiment 1

Change in variance of manipulation over time

Outline of experiment

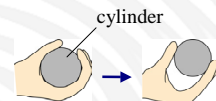
- Five subjects
- The link model for each subject is created in advance
- Template for each task is generated in advance



9

Three tasks

Task a Transition
heavy wrap prismatic grasp



Task b Transition
prismatic grasp heavy wrap

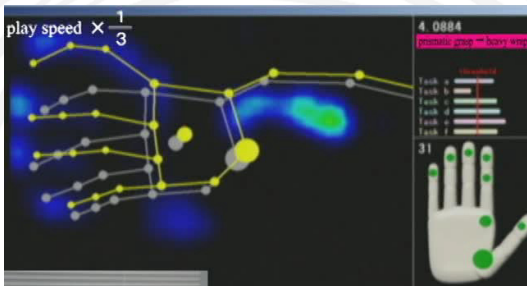


Task c Pillar axis rotation
(extending the thumb)



Grasping states : Cutkosky [1990] 10

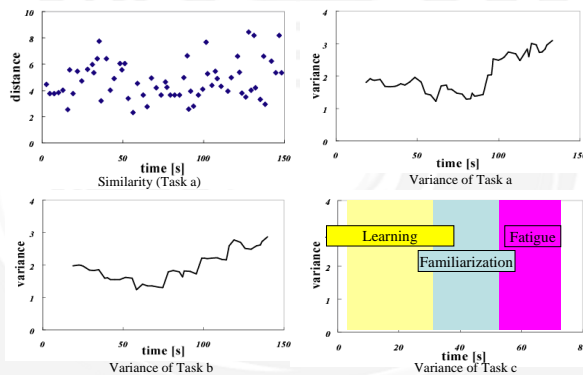
Demonstration - Task a and Task b



Task a
Transition from heavy wrap to prismatic grasp

Task b
Transition from prismatic grasp to heavy wrap

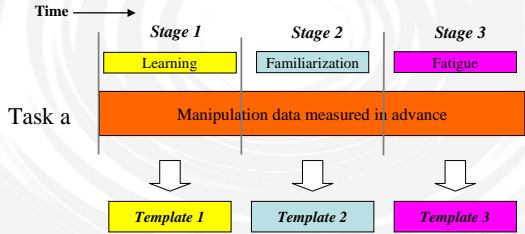
Similarity and variance



Experiment 2

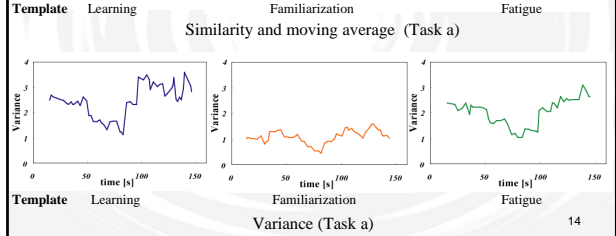
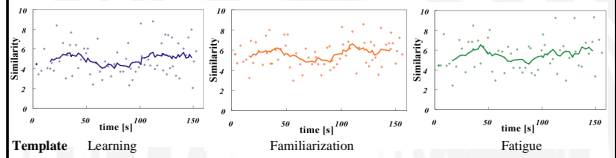
Change in the variance of manipulation with template for each time period

Three templates are generated by the process for each task



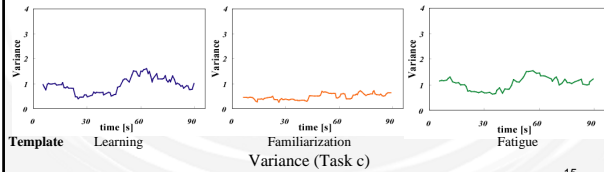
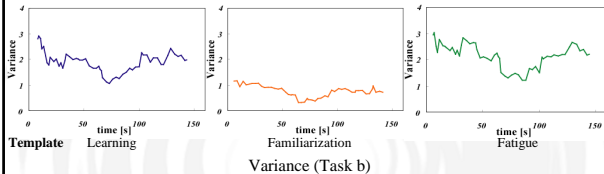
13

Similarity and variance (Task a)



14

Similarity and variance (Task b, c)



15

Discussion

- Subjects are able to learn easy/ordinary tasks in a short time
- Variance becomes small during familiarization stage
- Increase of variance during long period of manipulation indicates fatigue
- Template should be generated using data from the familiarization stage.

16

Conclusion

- Change in variance of manipulation over time was measured by observing the contact state transition.
- We can conclude that the change of variance showed stages of learning / familiarization / fatigue.
- Templates generated during the familiarization stage shows can be used to recognize motion with only a small variance
- Future work
 - Automatic generation of template based on familiarization
 - Evaluation using different object shapes

17