

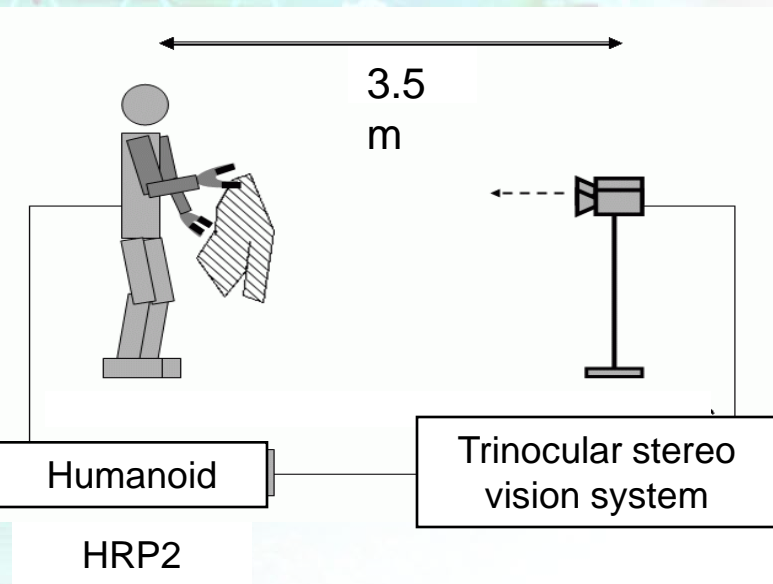
可変形状モデルを用いた 衣類特定部位把持手法

喜多泰代 植芝俊夫 Neo Ee Sian 喜多伸之

産業技術総合研究所

2009.9

実験システム



観測3次元データ



Three observed
images



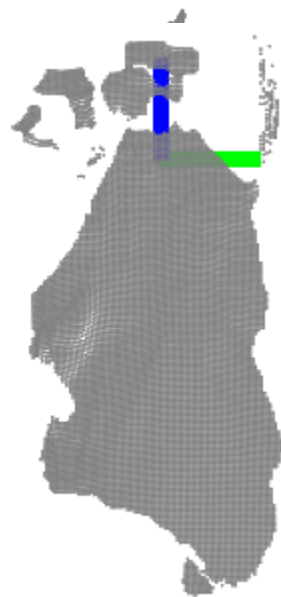
Trinocular stereo vision

[Ueshiba06]

 Camera
direction



Side view



Front view



Top view

特定部位把持のために必要な情報

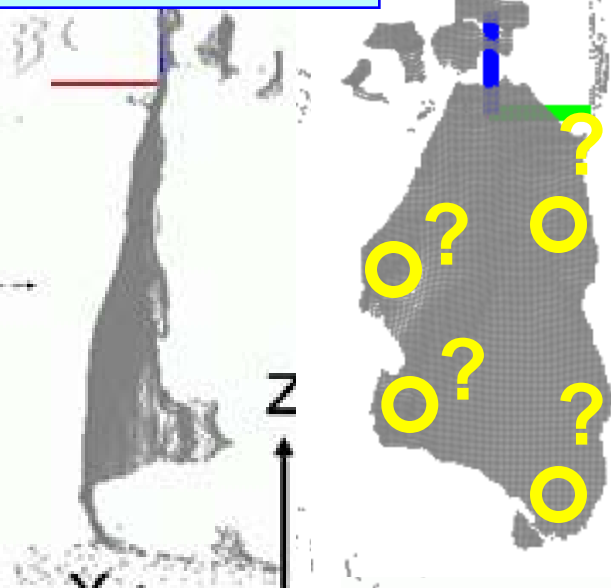
どの部位で把持されているのか？



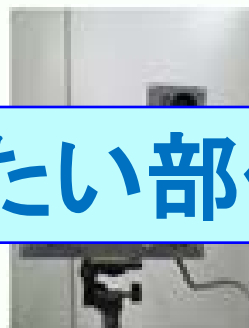
Three observed



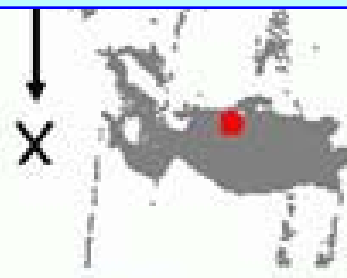
Camera
direction



次に把持したい部位はどこに存在するか？



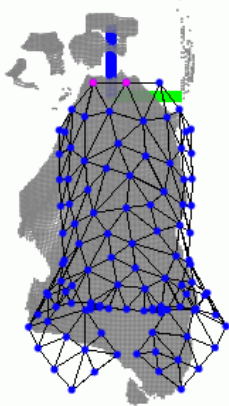
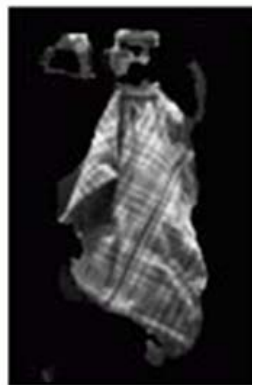
Trinocular stereo vision



Top view

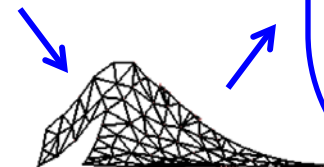
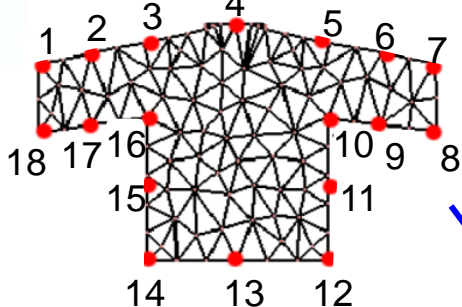
衣類の変形モデルを用いた 状態推定

Deformable model driven approach[Kita 04]

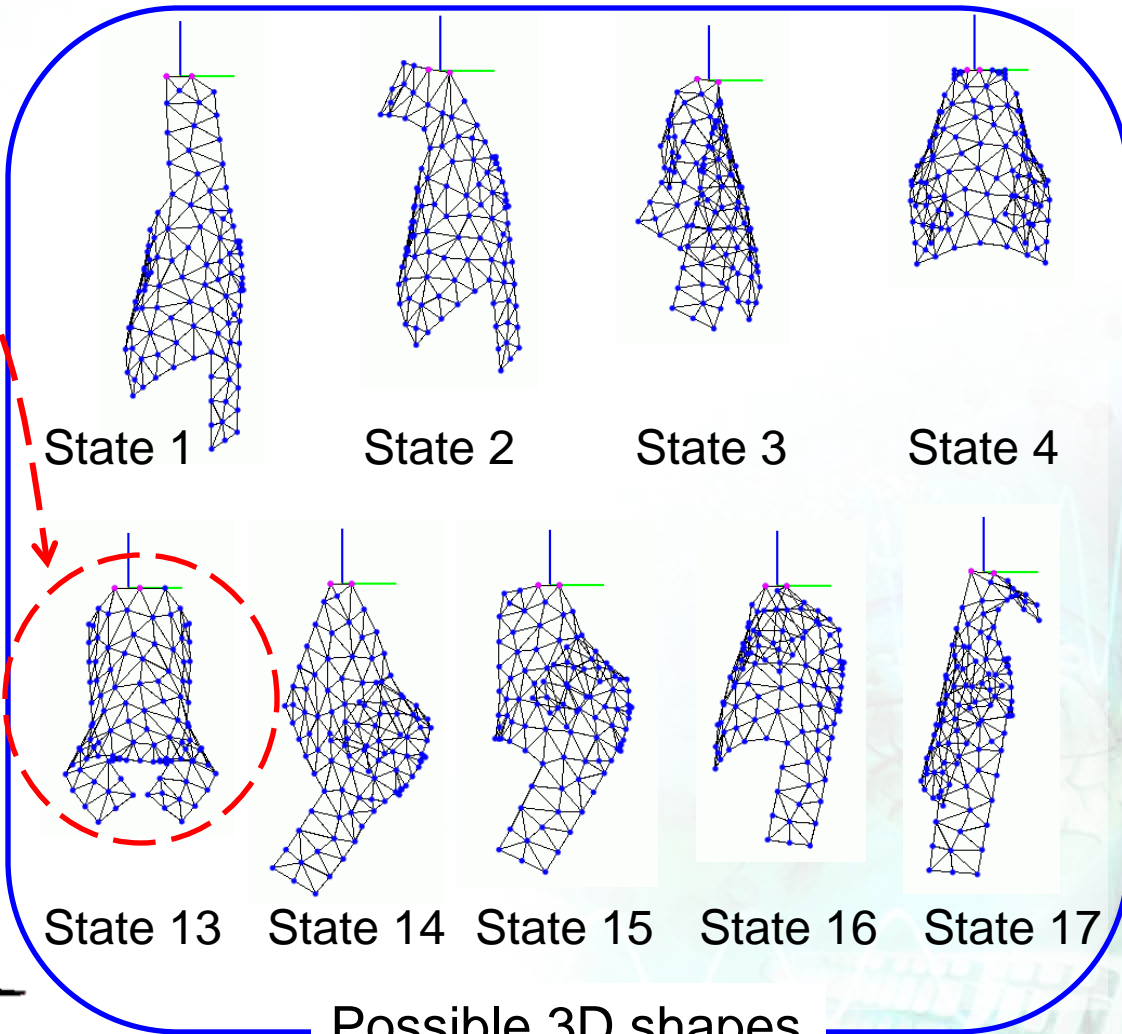


Observed 3D data

Deformable model



Simulation



State 1

State 2

State 3

State 4

State 13

State 14

State 15

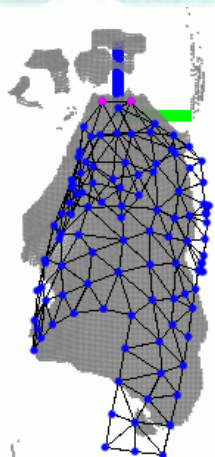
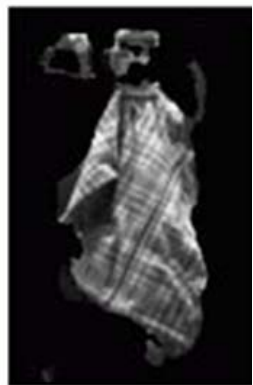
State 16

State 17

Possible 3D shapes

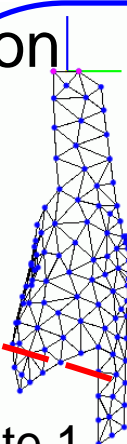
衣類の変形モデルを用いた 状態推定

Deformable model driven approach[Kita 04]

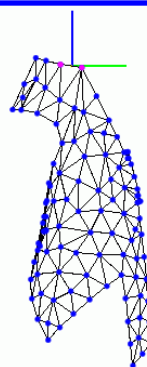


Observed 3D data

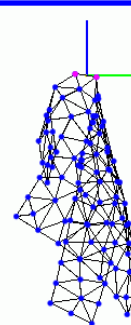
Comparison



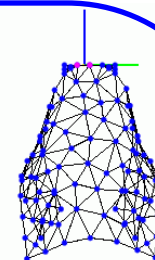
State 1



State 2

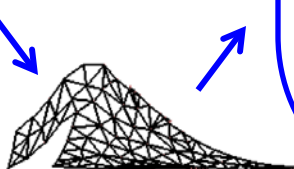
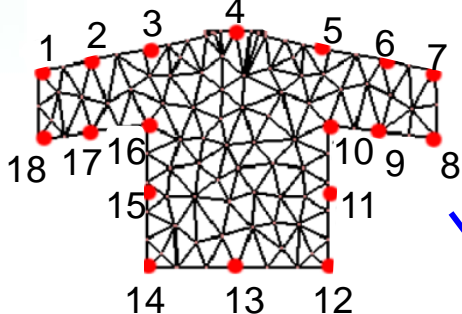


State 3

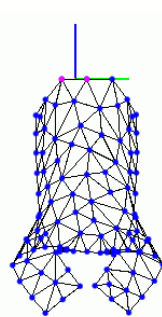


State 4

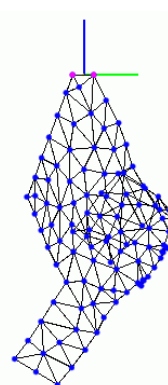
Deformable model



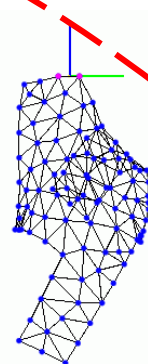
Simulation



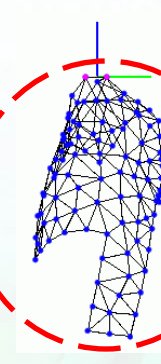
State 13



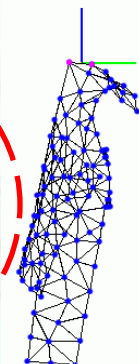
State 14



State 15



State 16

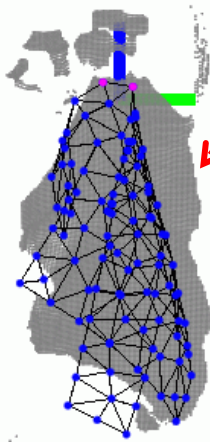


State 17

Possible 3D shapes

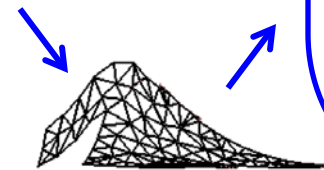
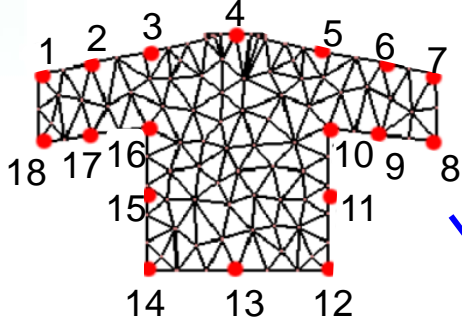
衣類の変形モデルを用いた 状態推定

Deformable model driven approach[Kita 04]

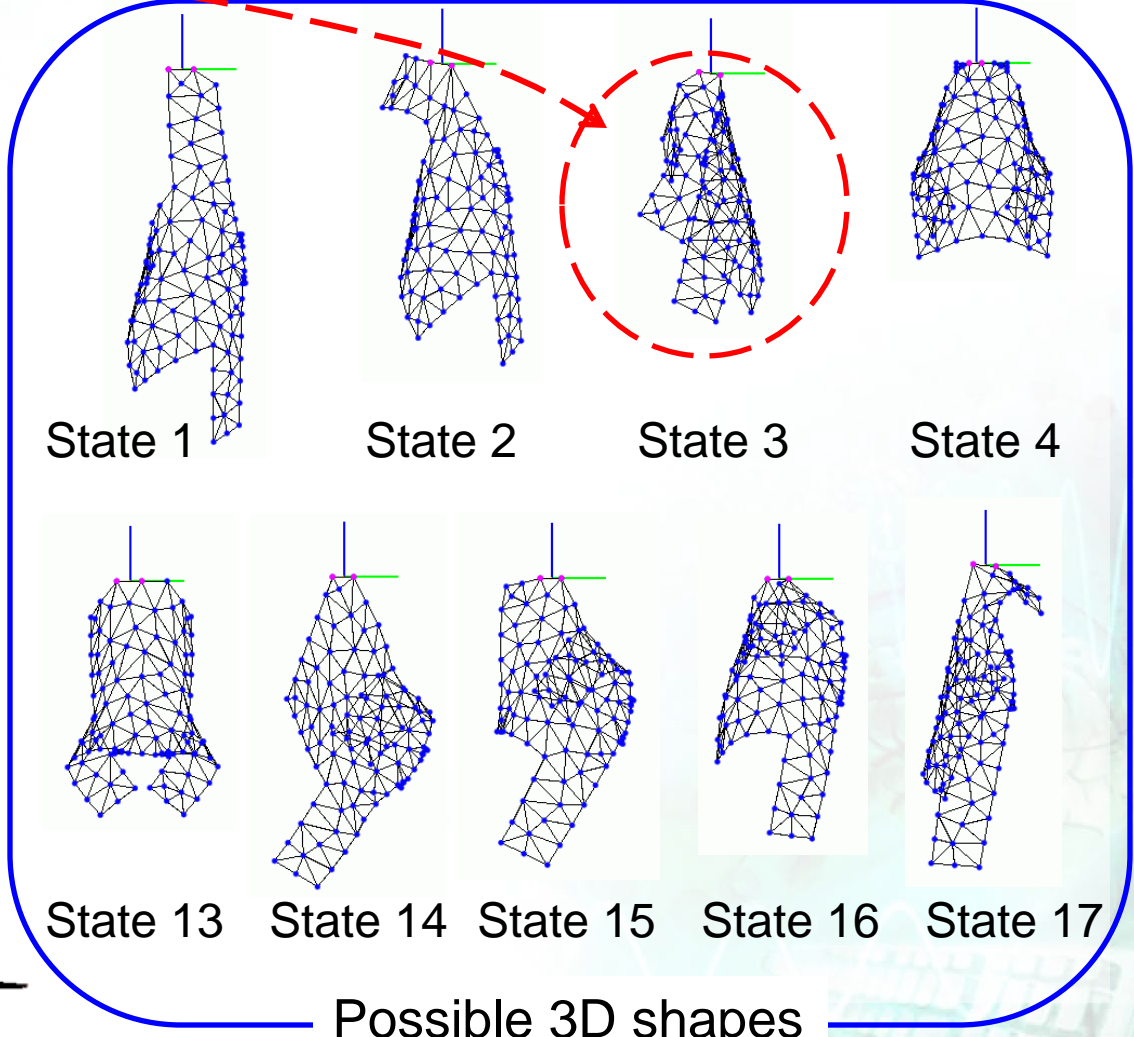


Observed 3D data

Deformable model



Simulation



State 1

State 2

State 3

State 4

State 13

State 14

State 15

State 16

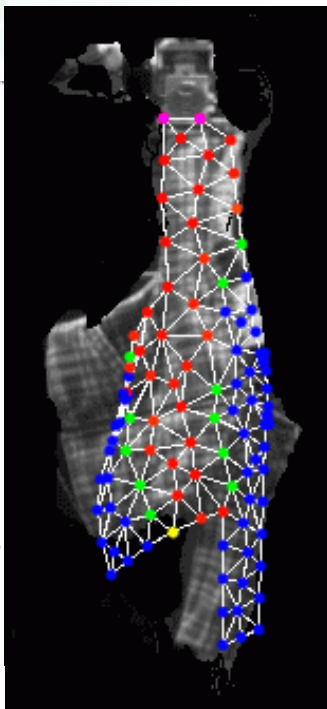
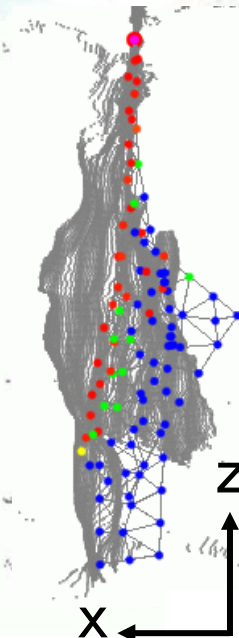
State 17

Possible 3D shapes

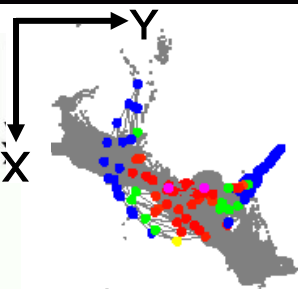
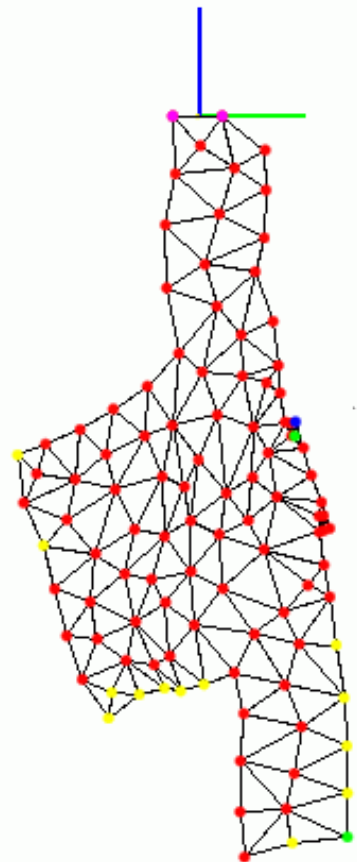
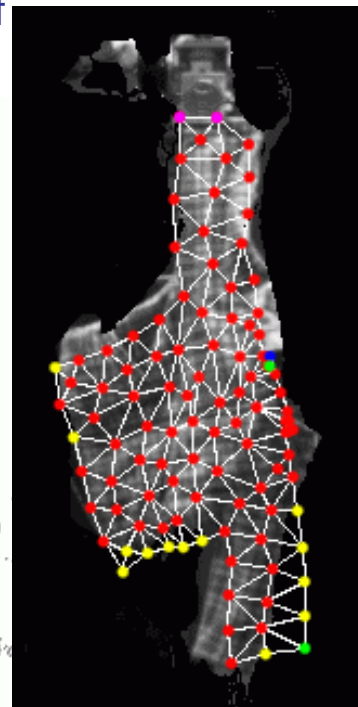
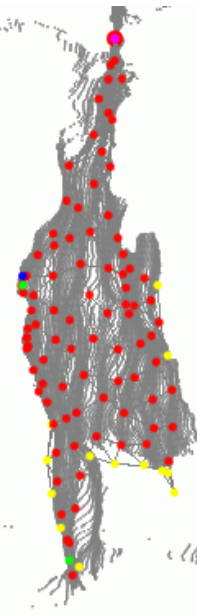
観測3次元データを用いた 予測形状の修正



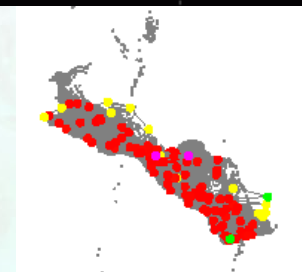
Side view of
3D data



Side view of
3D data



Top view of
3D data

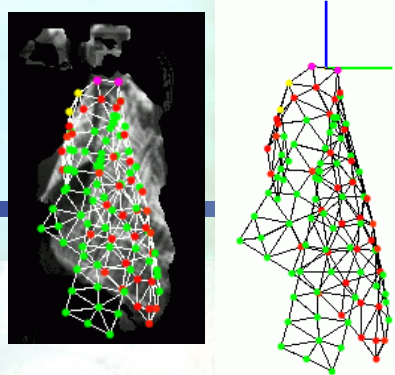


Top view of
3D data

- Off list of patch to attract
- On list of patch to attract.
- ● Within 25 mm from a
observed point
(More red, closer)

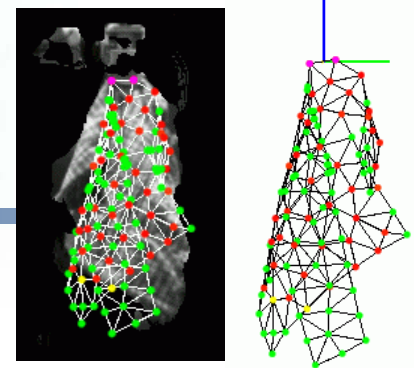


of
cience



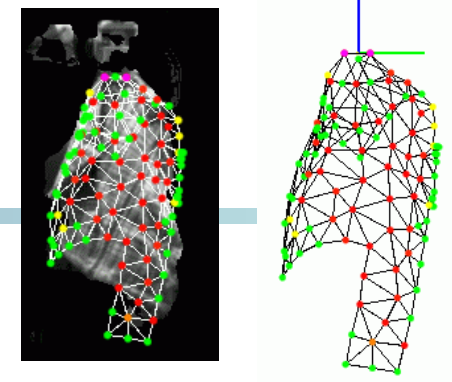
State 3

Correct state

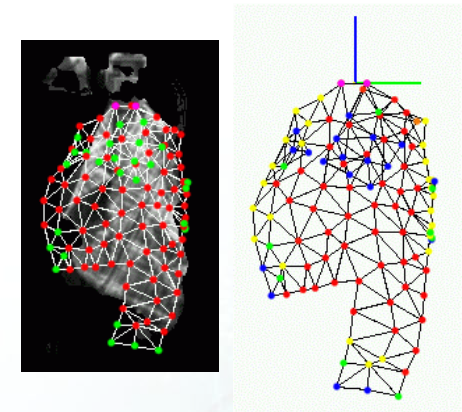
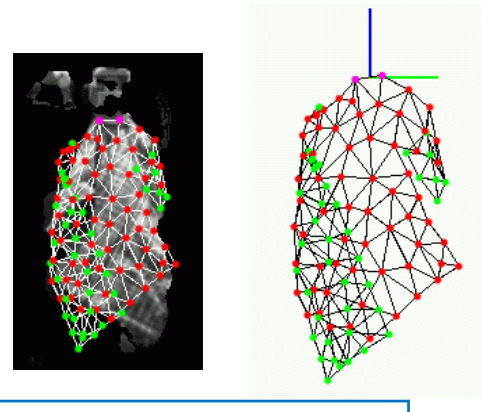
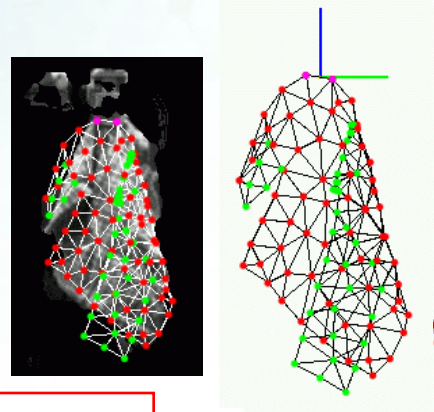


State 5

初期予測形状



State 16



状態推定

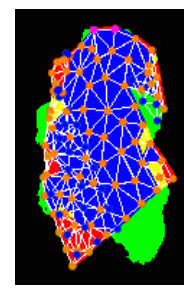
修正後の形状

- Observed region
- Visible model region
- Coincident region



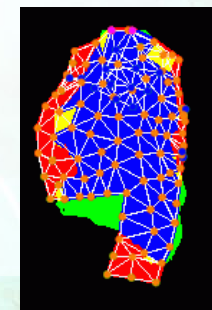
R=0.832

Selected



R=0.78

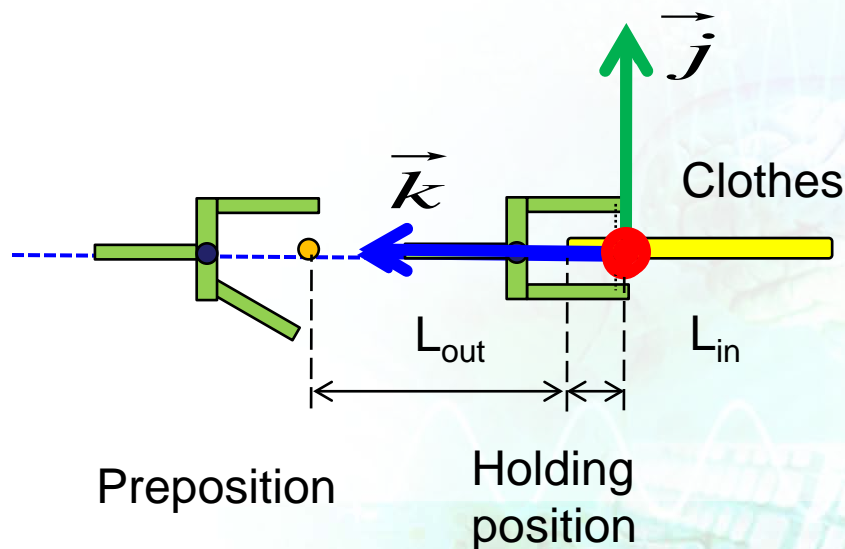
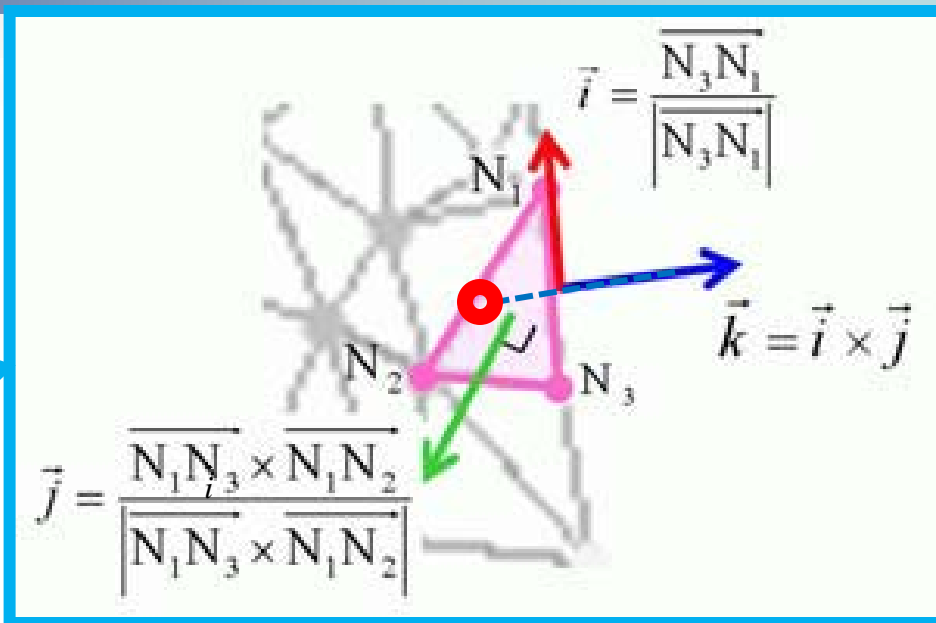
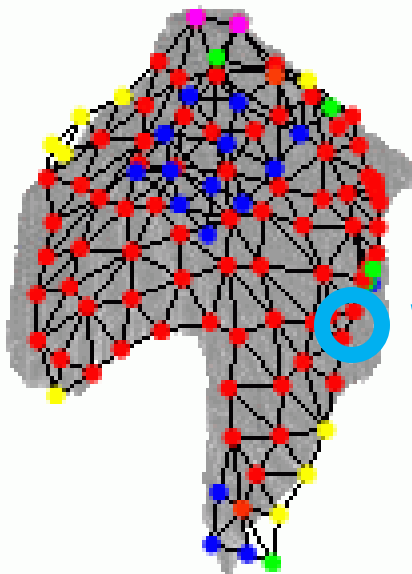
9



R=0.79

1

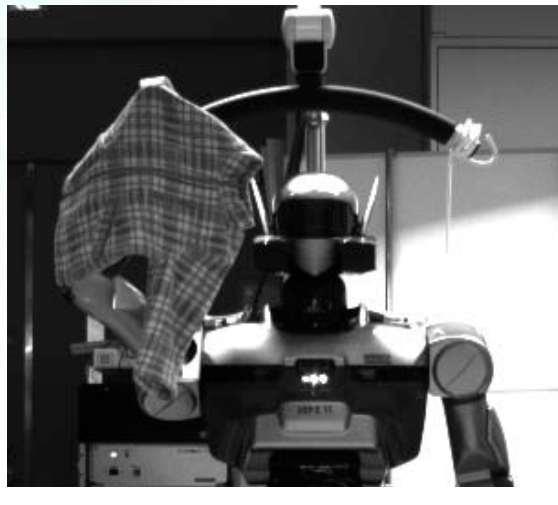
状態推定後に観測データに張り付いた衣類 モデルを利用した把持アクションの算出



実験



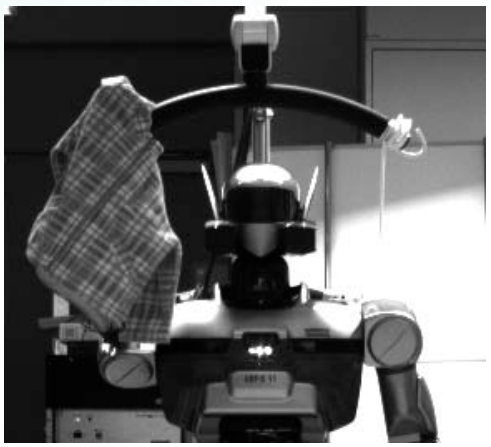
(a)



(b)



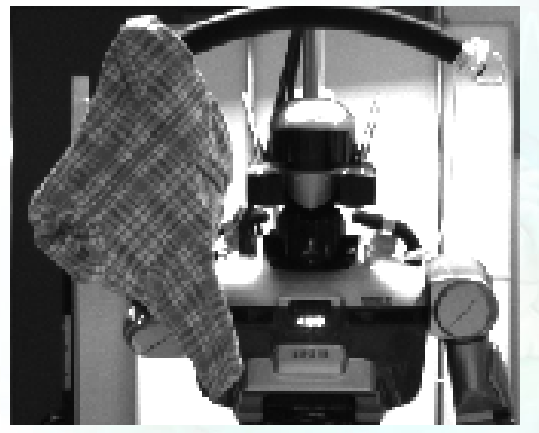
(c)



(d)

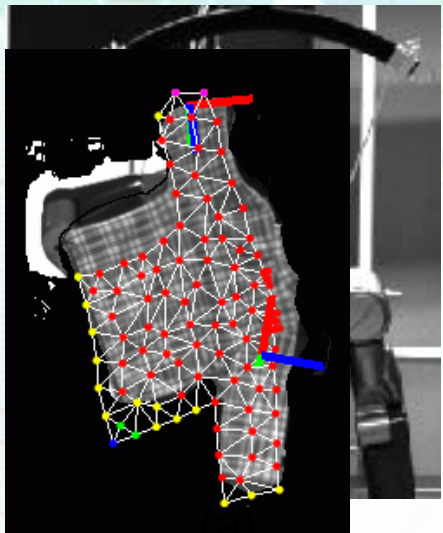


(e)

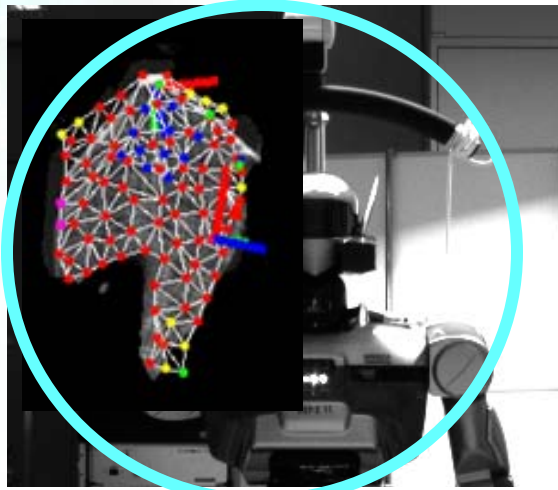


(f)

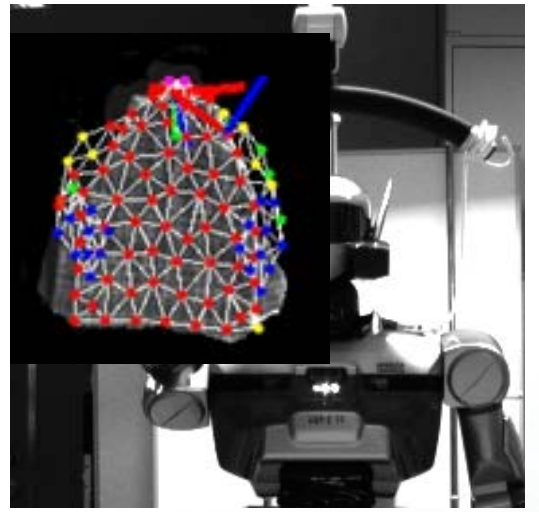
状態推定結果



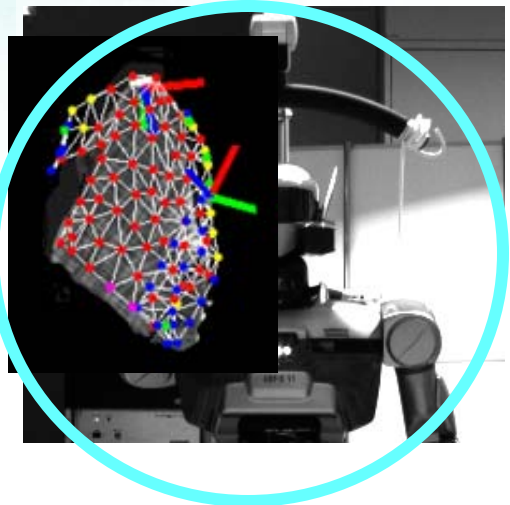
(a)



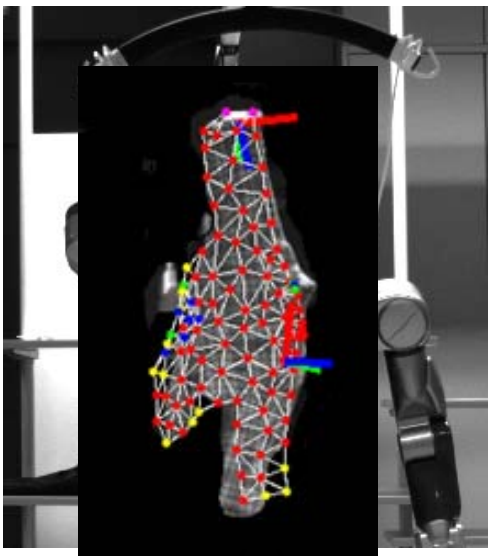
(b)



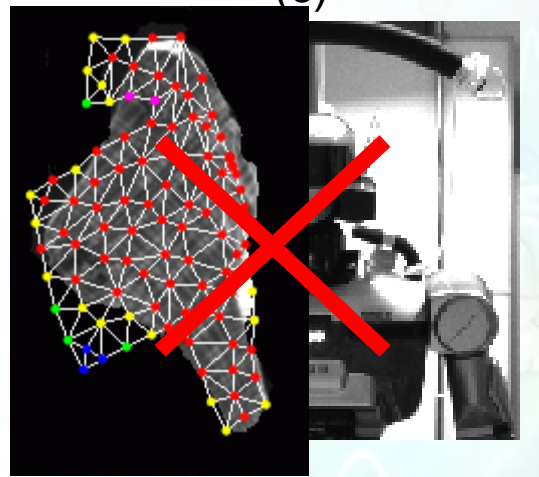
(c)



(d)

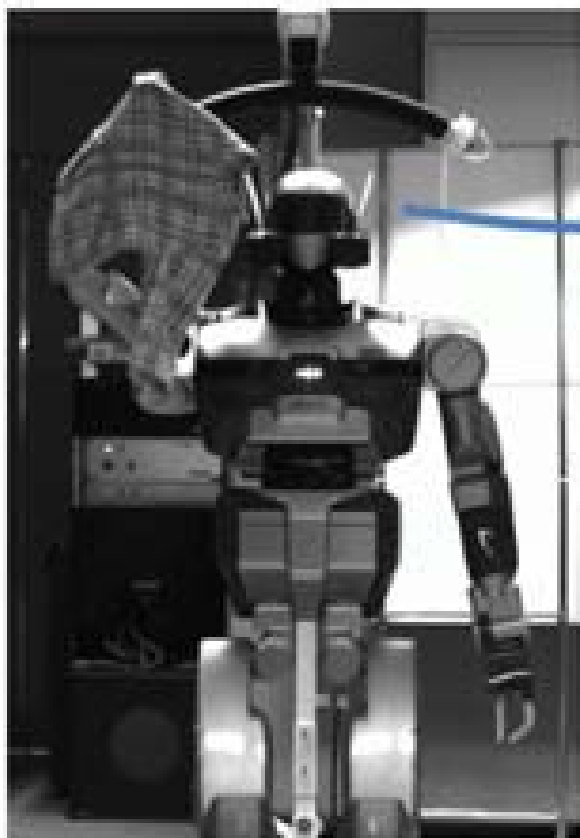


(e)



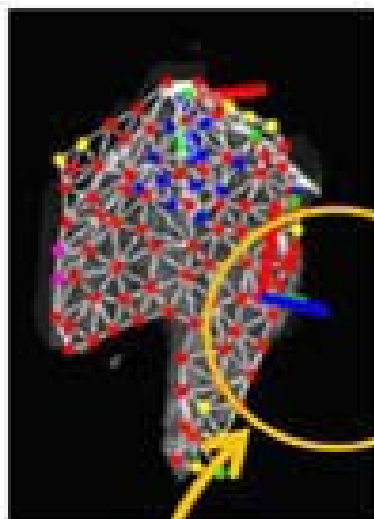
(f)

実験結果例1

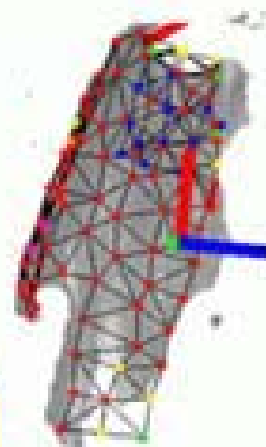


Observation

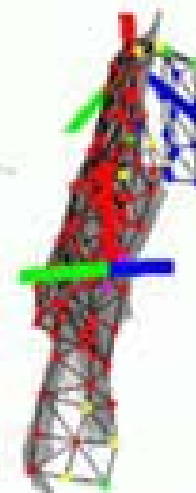
Estimation results



2nd hand coordinate
to grasp



View from
45° angle



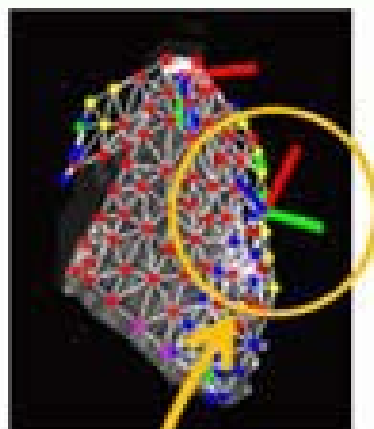
View from
90° angle

実験結果例2

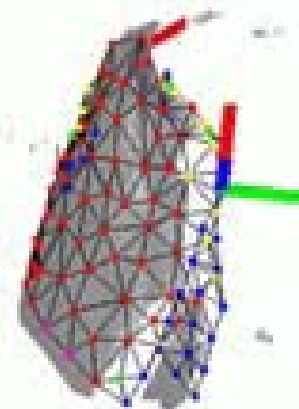


Observation

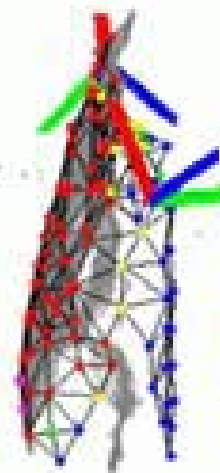
Estimation results



2nd hand coordinate
to grasp



View from
45° angle



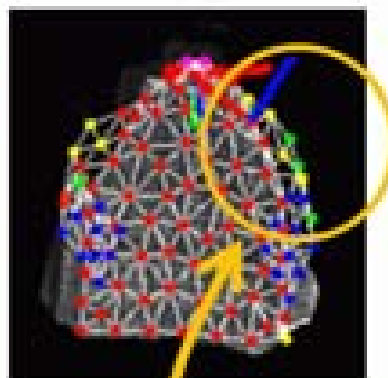
View from
90° angle

実験結果例3

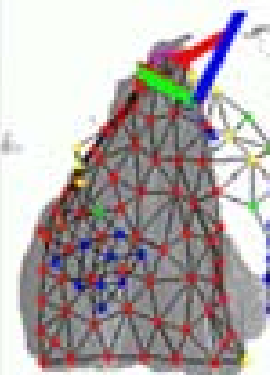


Observation

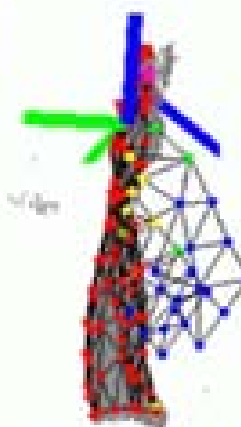
Estimation results



2nd hand coordinate
to grasp



View from
45° angle

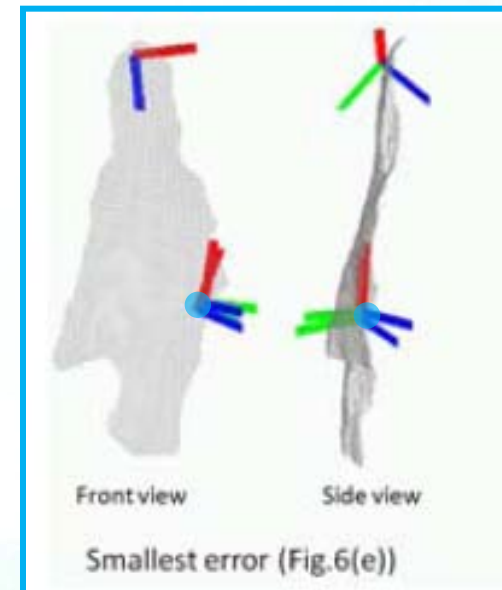
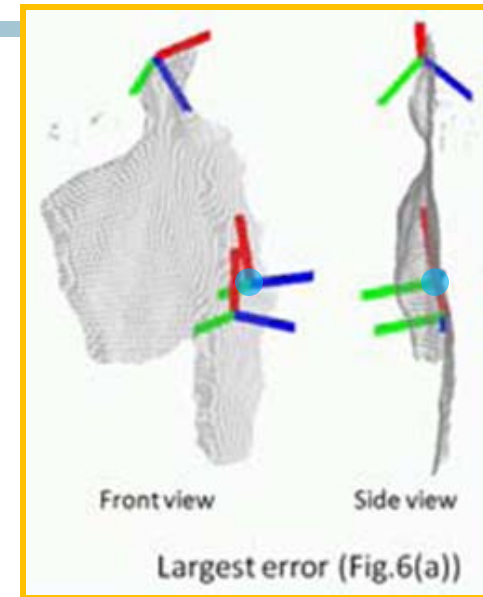


view from
90° angle

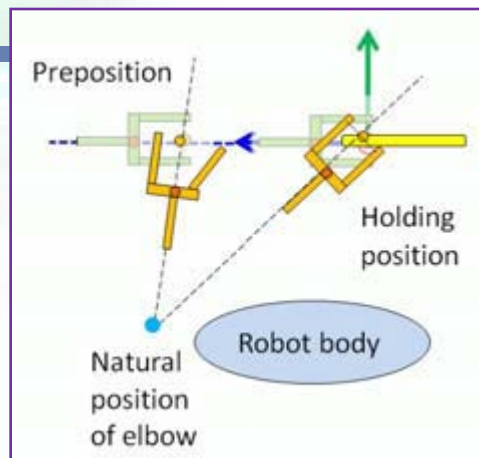
実験結果考察1:精度評価

Table 1 Differences of resultant hand coordinates from ones by manually obtained difference

	X-axis	Y-Axis (degree)	Z-axis	origin (mm)
(a)	10.2	8.8	12.8	53.5
(b)	5.8	13.8	13.6	26.3
(e)	12.2	13.2	12.4	14.5
average	9.4	12.0	13.0	31.4

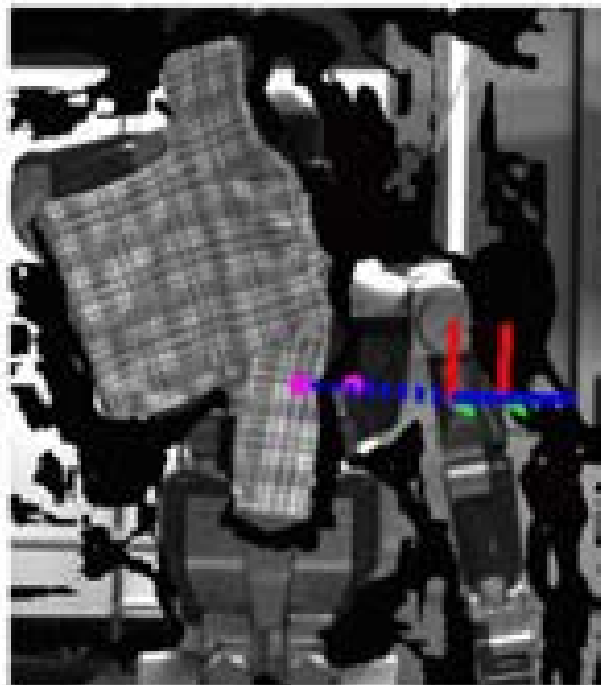


実験結果考察2: 実行可能性

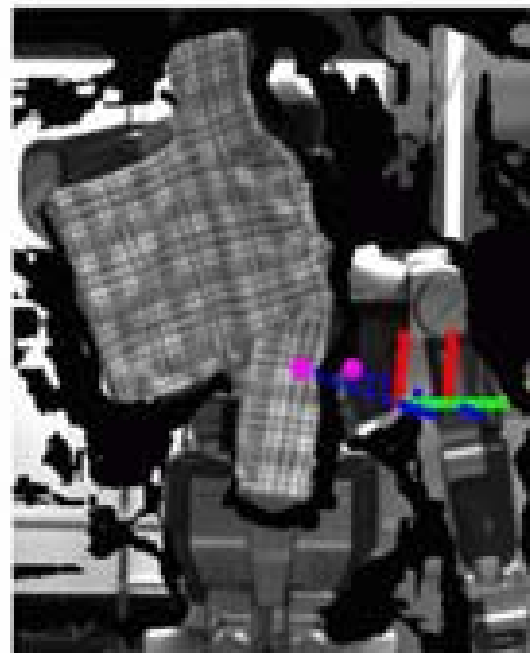


実行不可能な例

修正後のアクション例

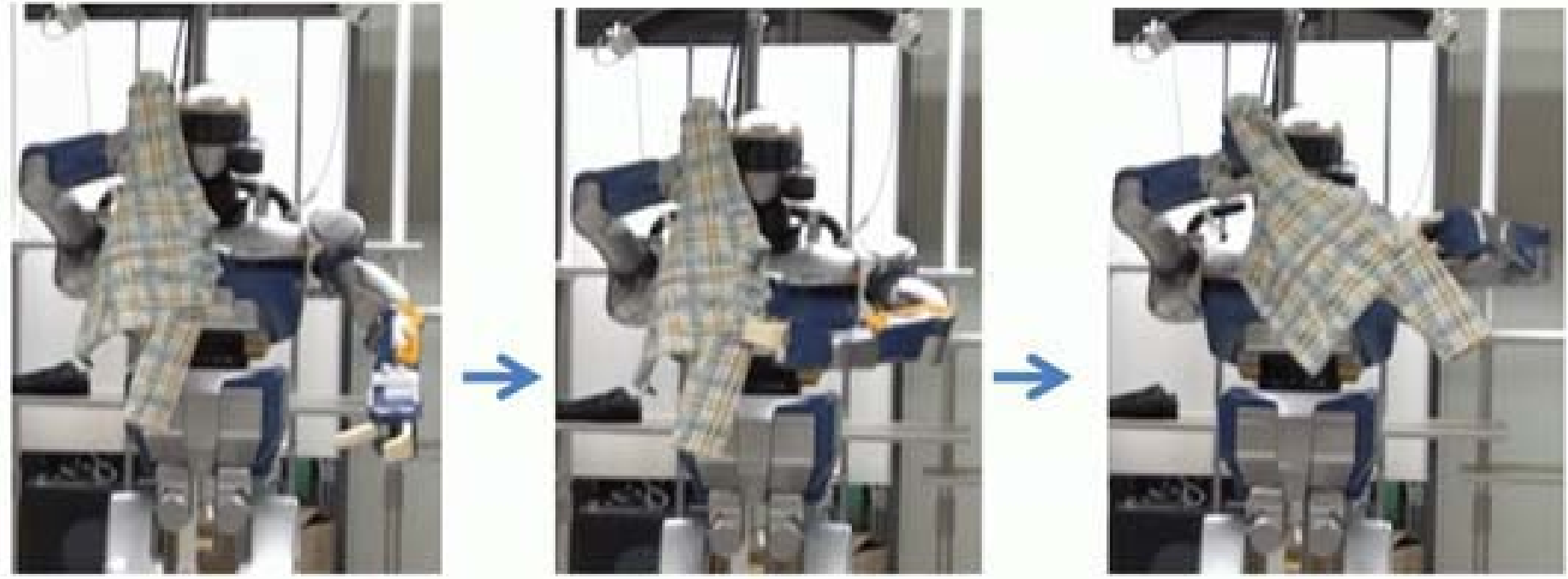


Side view



Side view

動作例





動作例



まとめ

空中に片手で把持された衣類の状態を視覚認識した結果に基づき、肩などの特定部位をもう片方の手で把持するためのアクション(把持位置、姿勢、アプローチ方向)を自動算出する手法を提案し、実装した。

- 1) 衣類の柔軟モデルを観測データに一致するように変形するモデル駆動型のアプローチにより、ターゲット部位に対応するモデルセグメントの3次元情報から理想的な把持位置、姿勢が算出可能。
- 2) ヒューマノイドを用いた実験を通じ、その精度、及び、動作実現上の問題点の考察を行った。

まとめ

空中に片手で把持された衣類の状態を視覚認識した結果に基づき、肩などの特定部位をもう片方の手で把持するためのアクション(把持位置、姿勢、アプローチ方向)を自動算出する手法を提案し、実装した。

今後の課題

- 1) 算出した理想的な把持アクションにできるだけ近い、実行可能アクションを算出し、連続的なハンドリング実験を遂行
- 2) アクションと視覚認識部の連携を活用し、処理の頑健性の向上