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3次元観測データを用いた衣類形状推定

衣類の可変形状モデルを用いた状態推定法

喜多泰代　植芝俊夫

産業技術総合研究所

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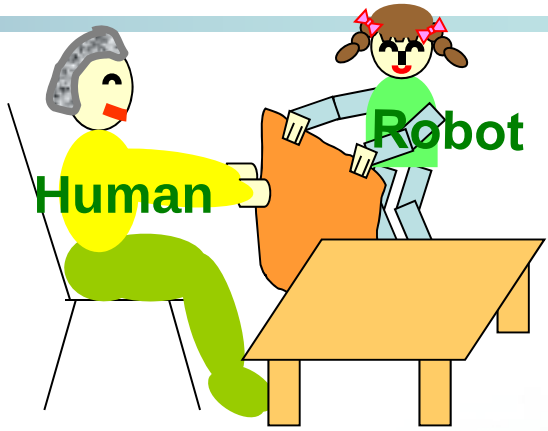
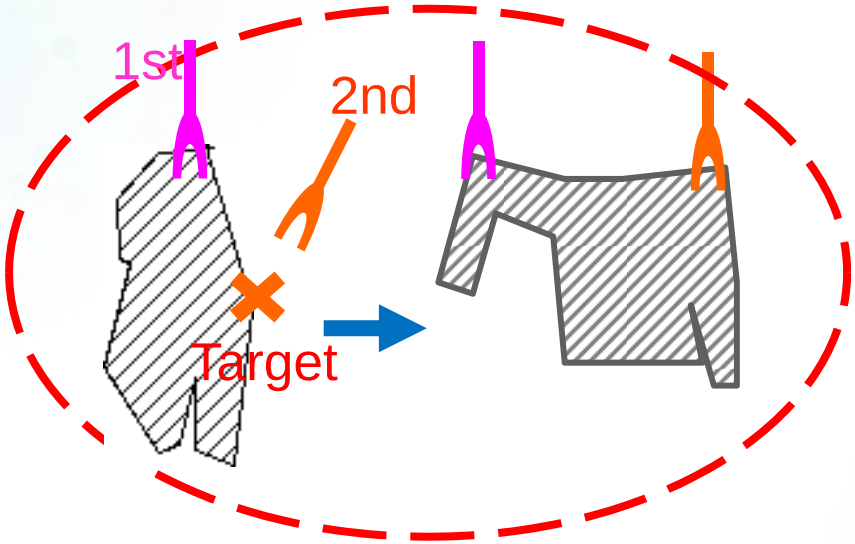
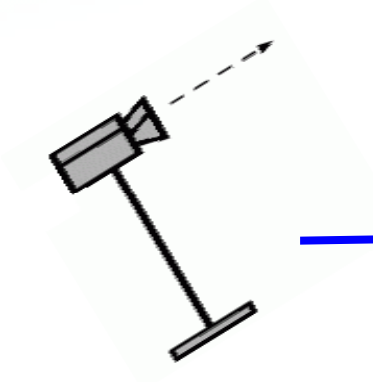
課題：衣類自動ハンドリングを目標とする衣類状態認識

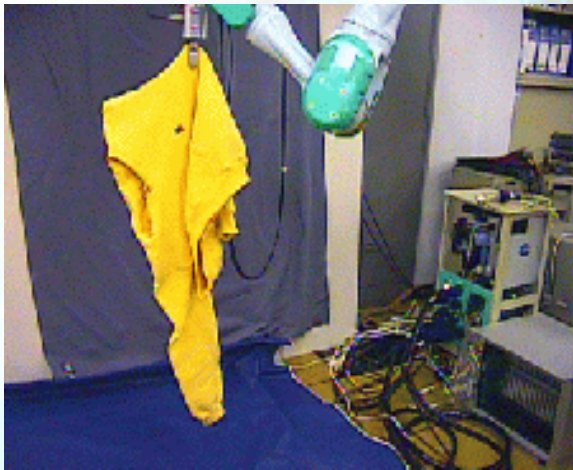
「各部位がどの位置、どの向きに存在」







ハンドリングに
必要な情報



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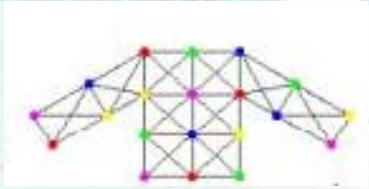
基本戦略：予測形状を用いた状態推定

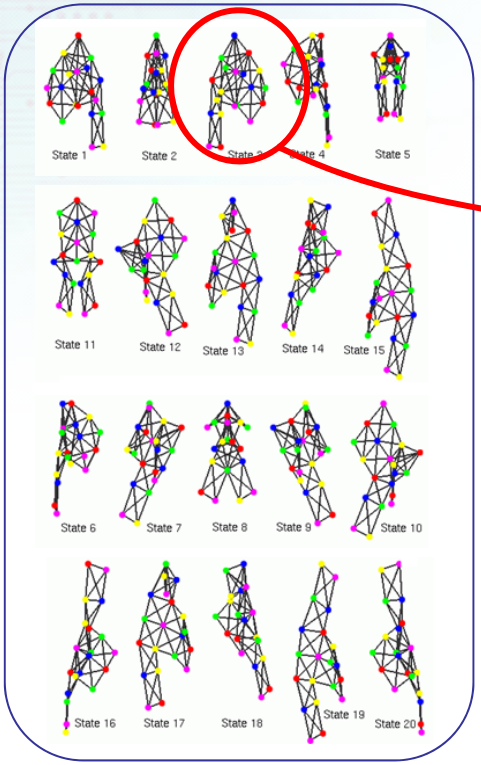
Deformable model driven approach[Kita 04]

前提： 対象衣類の種別、
大体のサイズ、柔らかさ既知

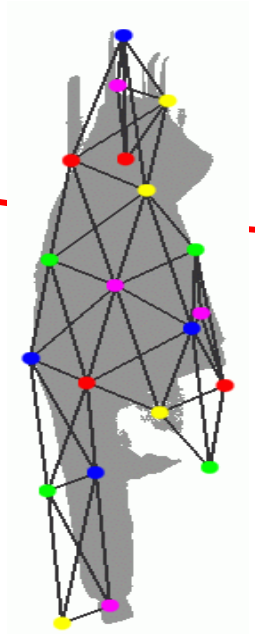


可変形状モデル

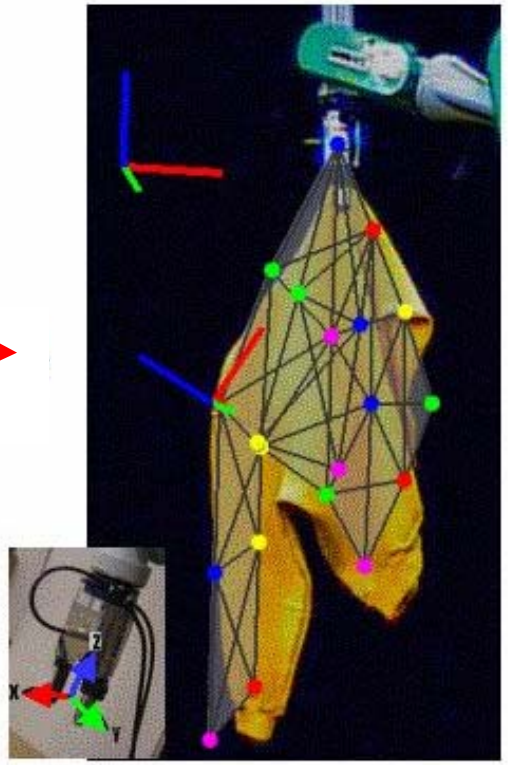
変形シミュレーション



起こりえる形状予測



観測領域との
一致度評価



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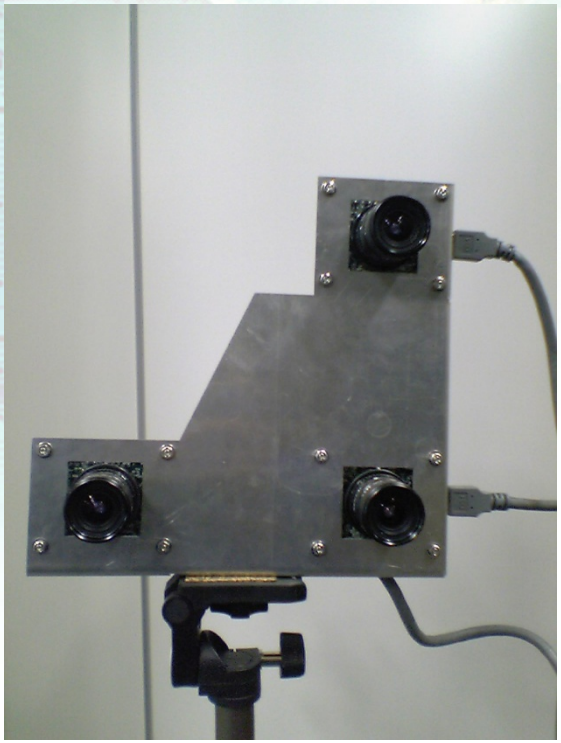
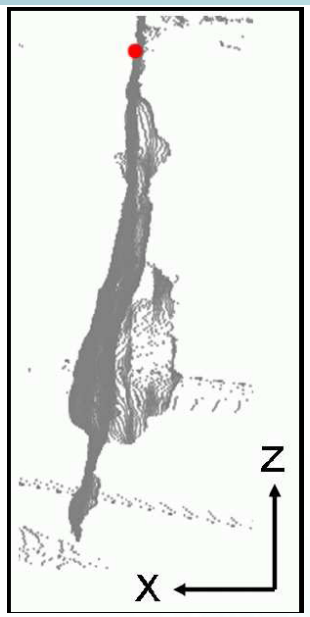
3次元観測データの活用



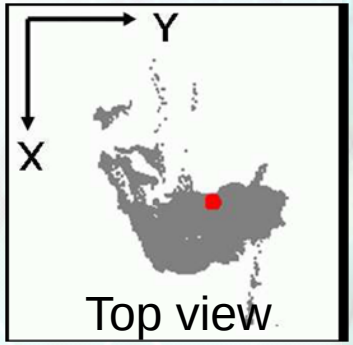
3次元リアルタイム
ステレオビジョン

3枚の濃淡画像



Side view

3次元点データ
（距離画像）



Real-time Trinocular Stereo Vision [Ueshiba06]

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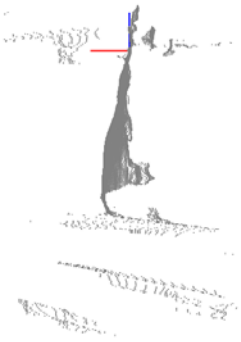
3次元観測データの活用

長所

衣類領域抽出に関する優位性

Front view

Side view



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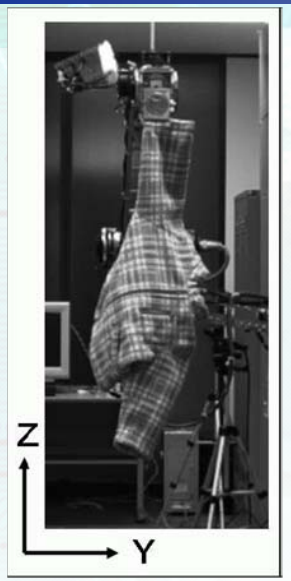
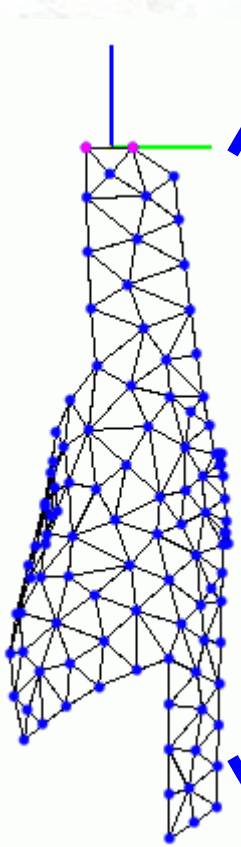
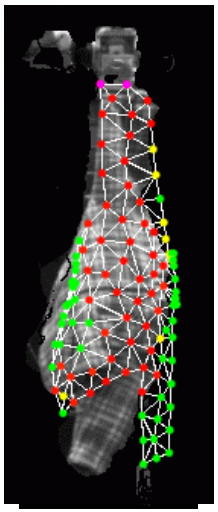
予測形状と観測形状の違い

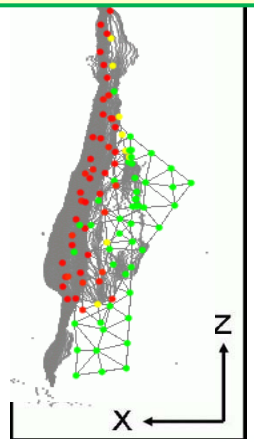
緑の部分は一致していない



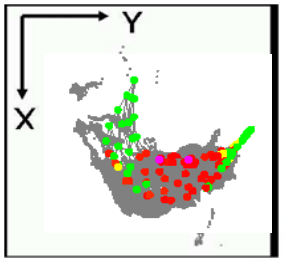




Front view

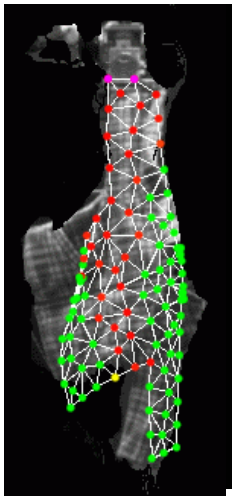


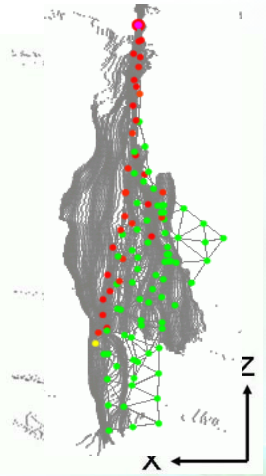
Side view

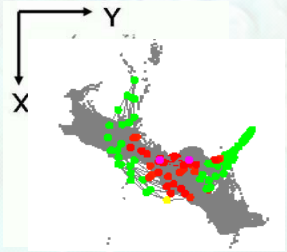


Top view

予測形状







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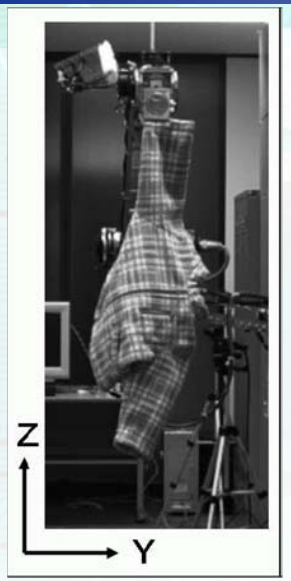
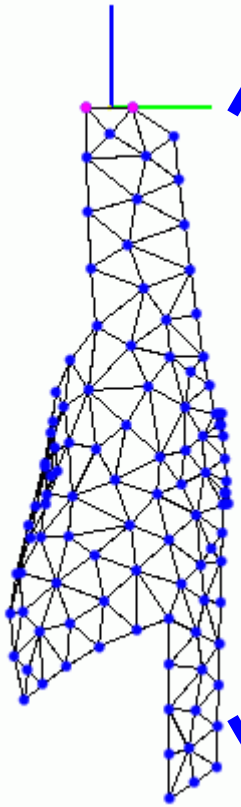
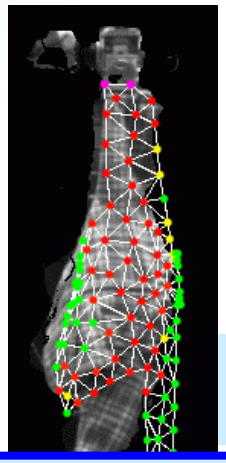
3次元観測データ利用の特性

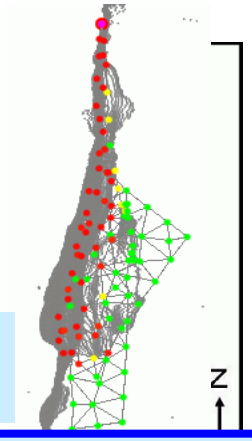


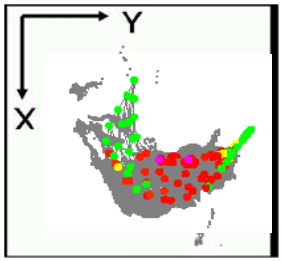


予測形状

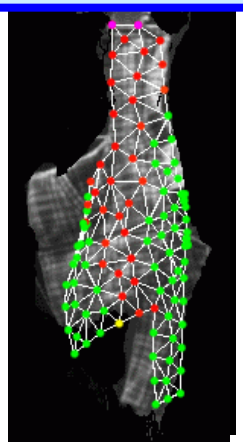


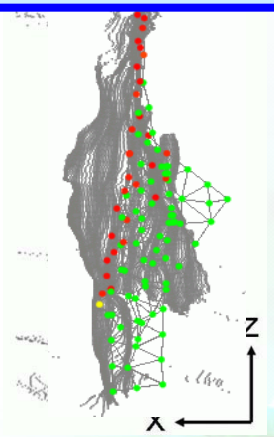
提案

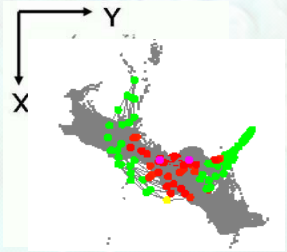




可変形状モデルを用い、観測3次元データに一致するように変形修正







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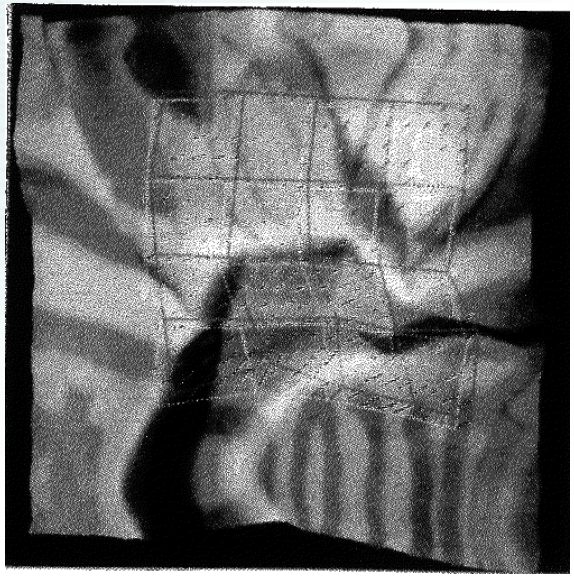
関連研究：柔軟物追跡

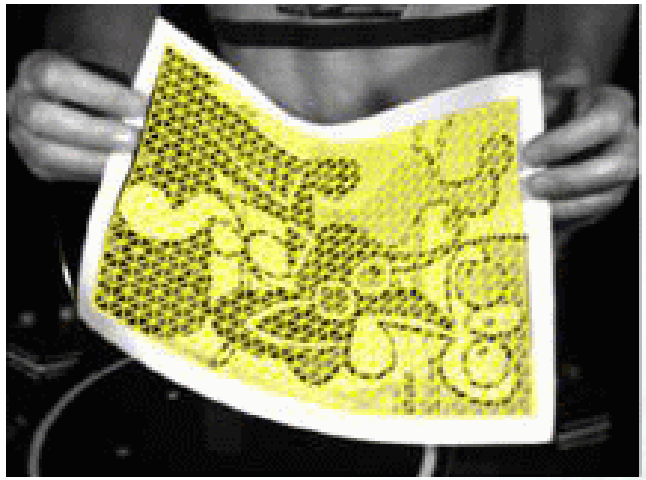
[Yamamoto 93]



近い初期予測

⇨精度の良い初期予測必要

[Pilet 06]



特徴的なテクスチャ

⇨ 対象を制限

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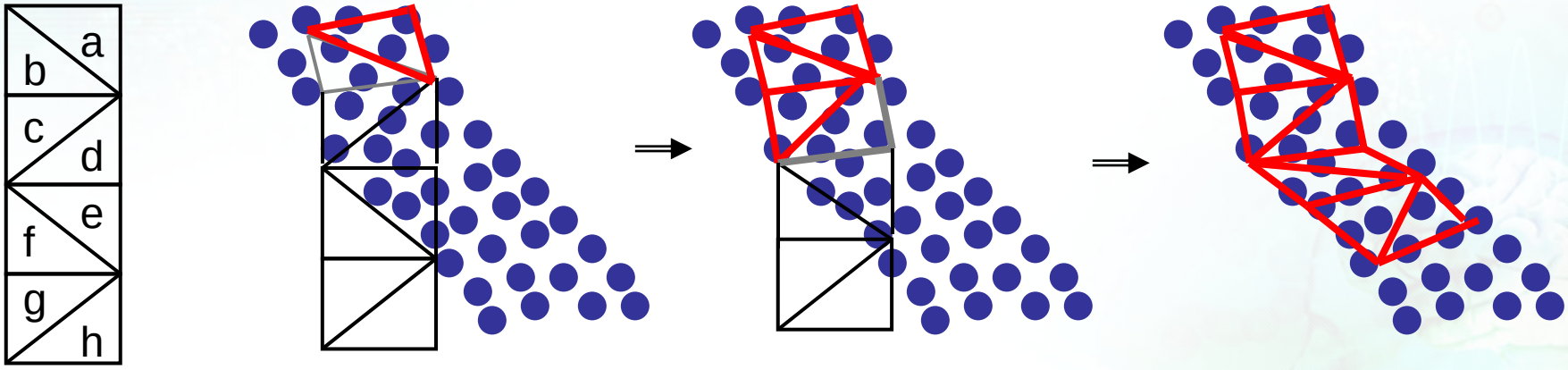
提案手法

アクションにより、
　把持位置の3次元座標、面の向き能動的に設定可能

＝＞　一致している部分から順番に張り合わせるように
予測形状を変形していく。

● 観測データ点



力を加える
パッチリスト

(a,b)

(a,b,c,d)

(a,b,c,d,e,f,g,h)

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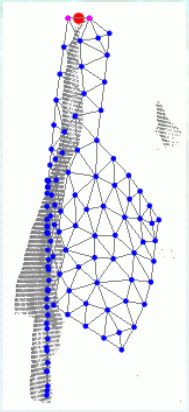
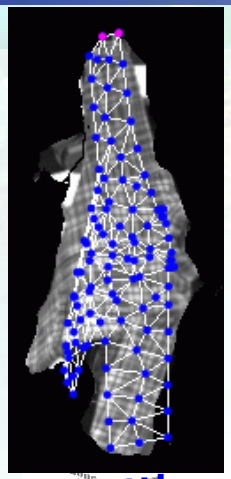
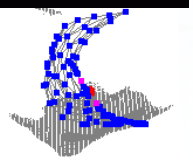
実験結果1-1：形状修正

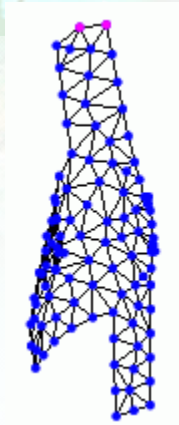


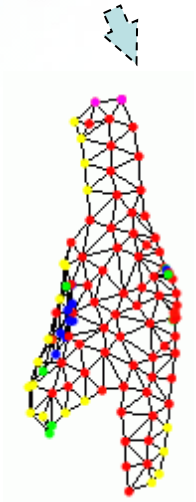
Side view

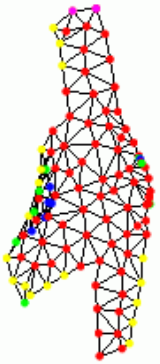


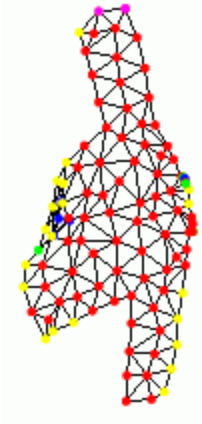


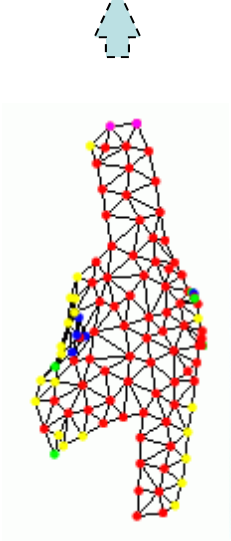
Top view

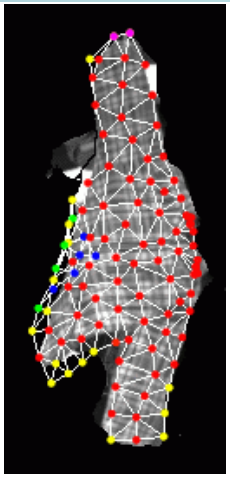




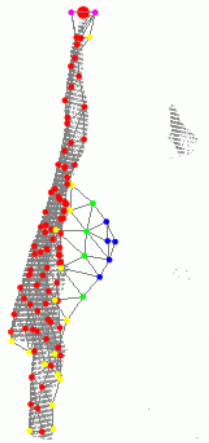






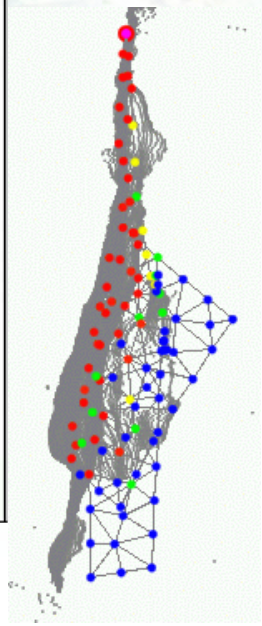


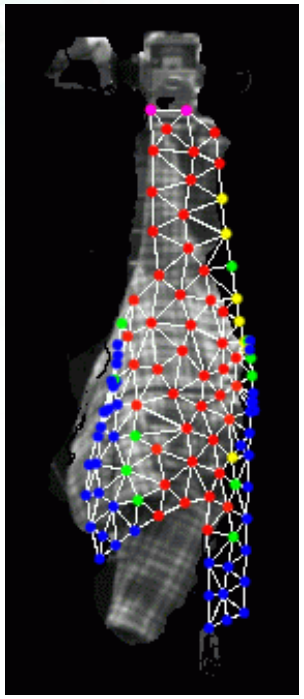
Top view

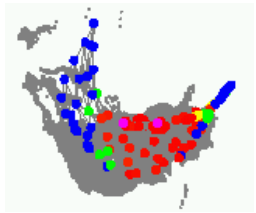


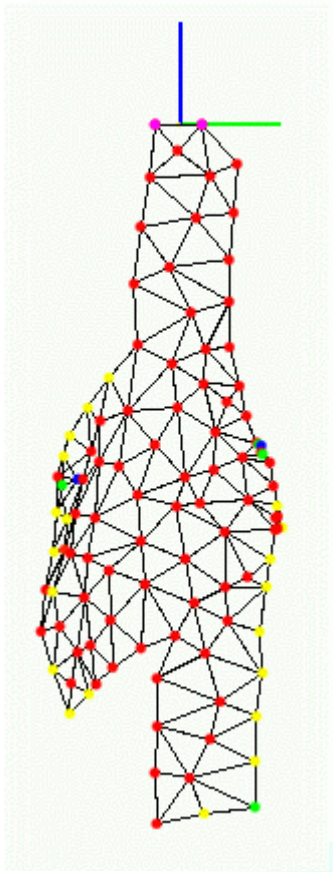
Side view

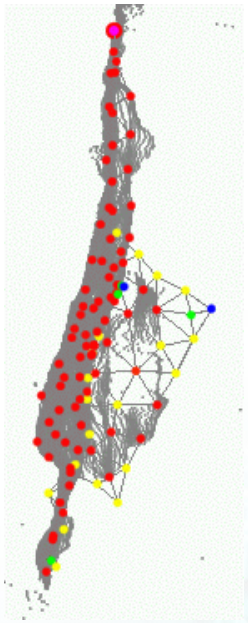
実験結果1-2：形状修正

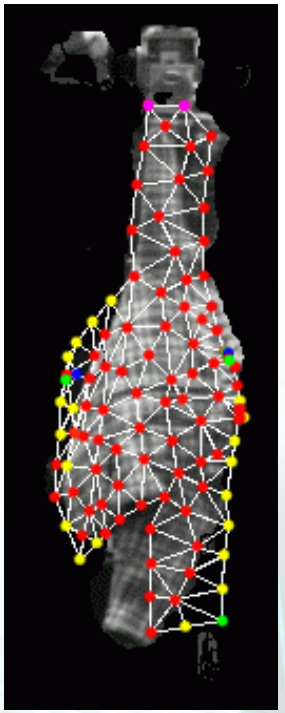


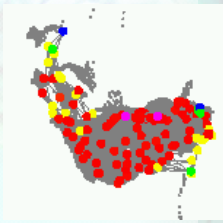












- パッチリスト未登録
- パッチリスト登録
- パッチリスト上、観測データに近い点（赤いほど近い）

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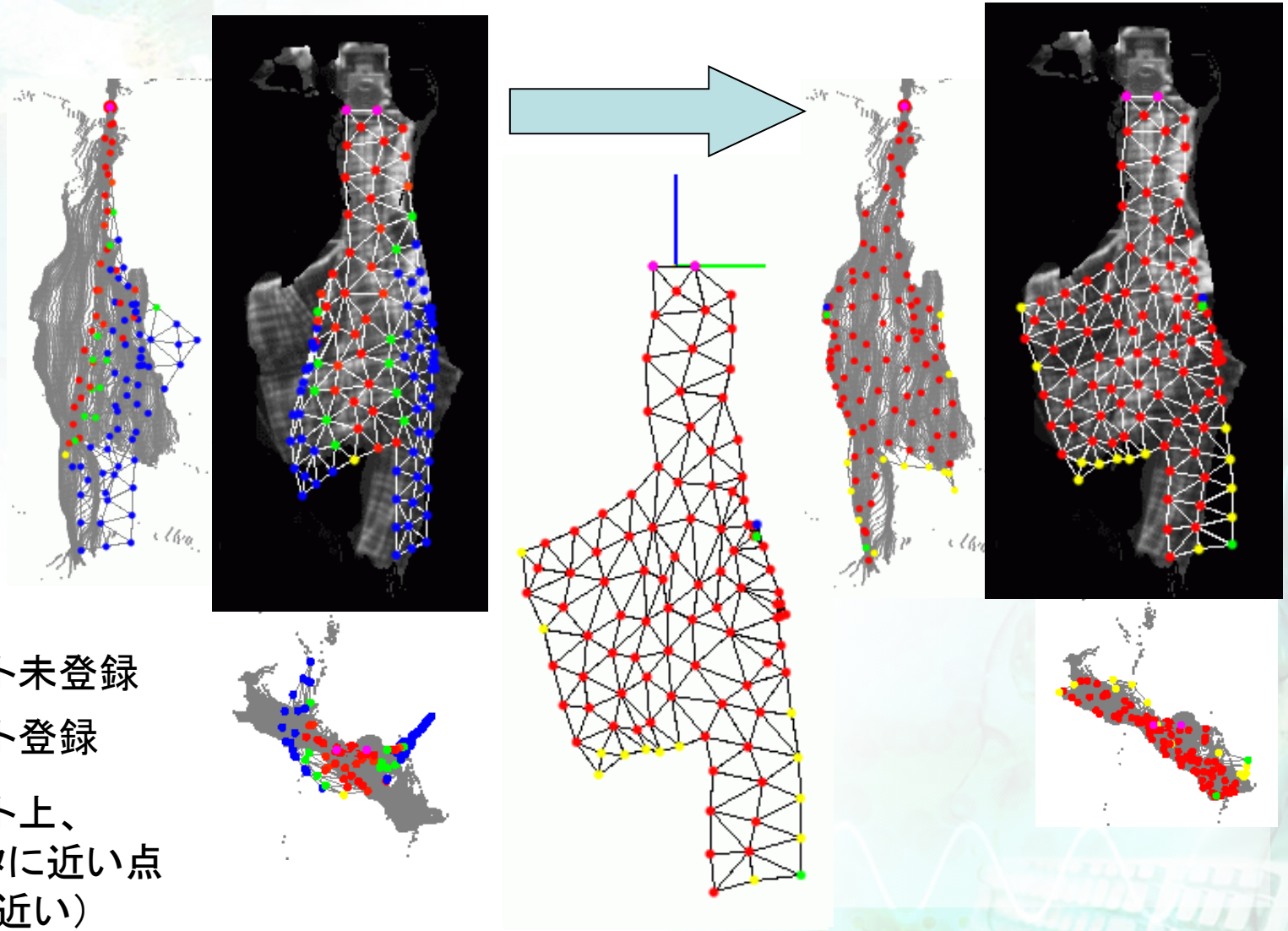
実験結果1-3：形状修正



- パッチリスト未登録
- パッチリスト登録
- パッチリスト上、観測データに近い点（赤いほど近い）

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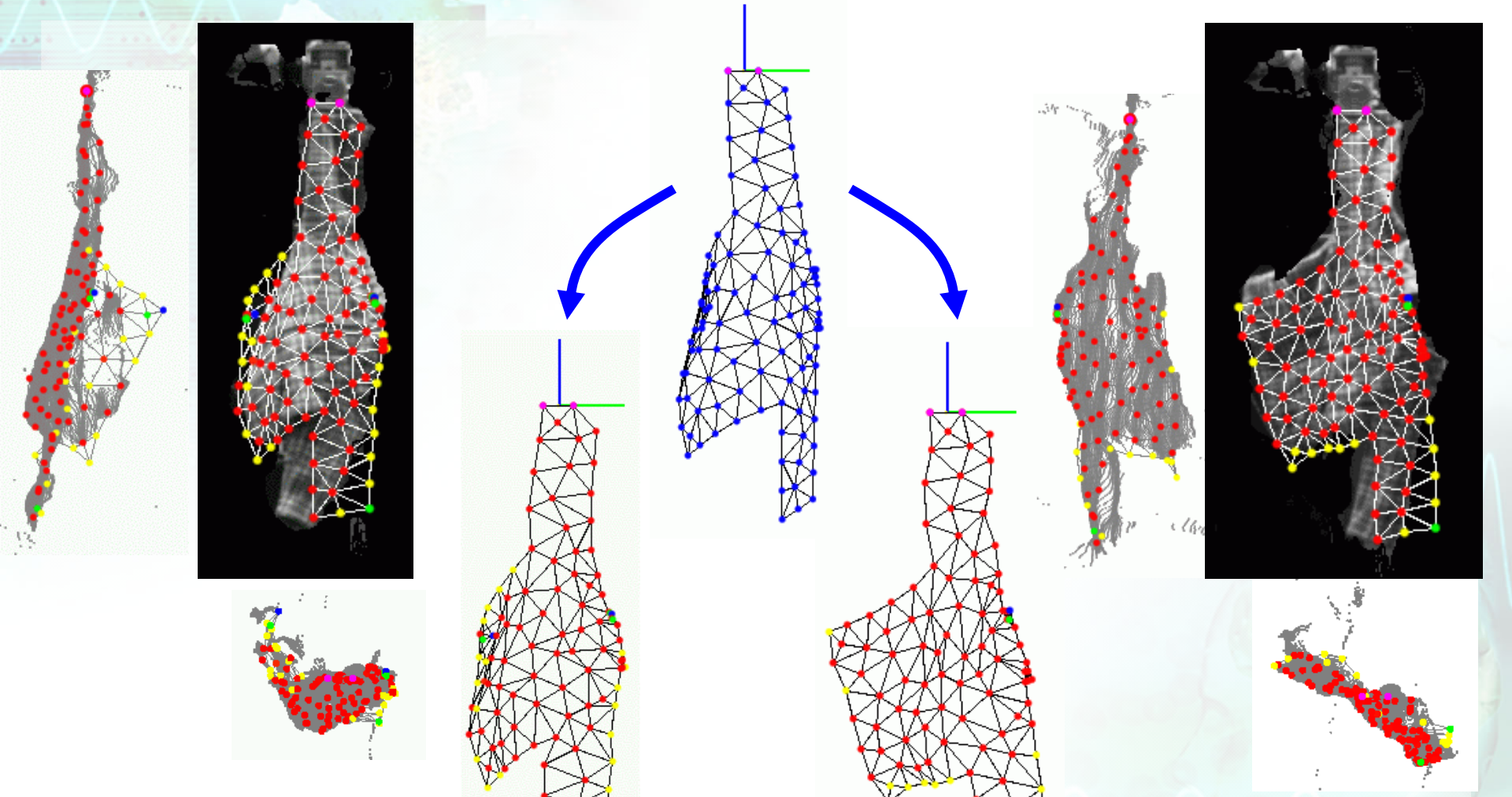
実験結果1-2,1-3：形状修正



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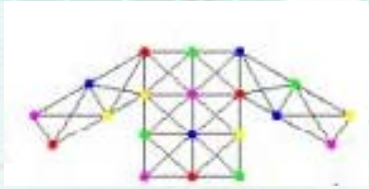
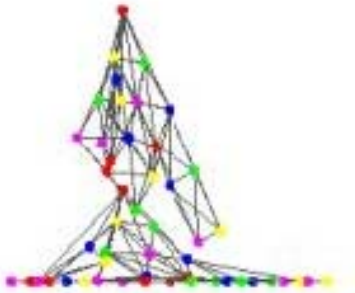
実験2：形状推定への効用

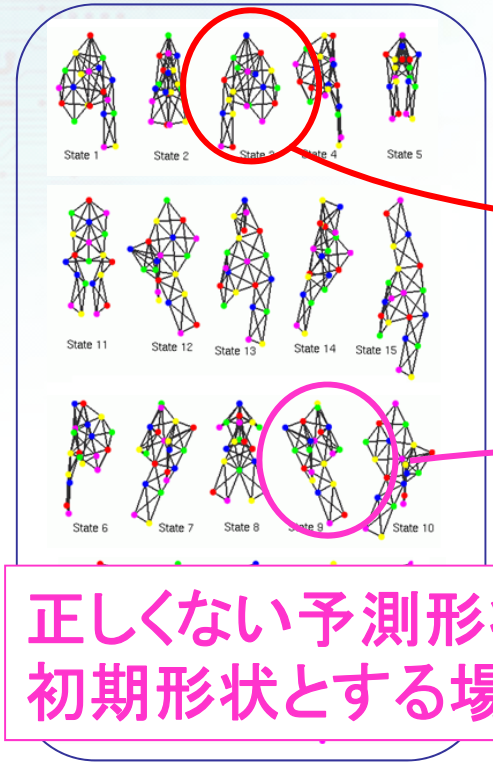
Deformable model driven approach[Kita 04]



可変形状モデル

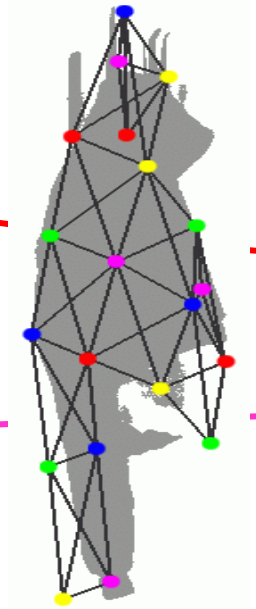


変形シミュレーション

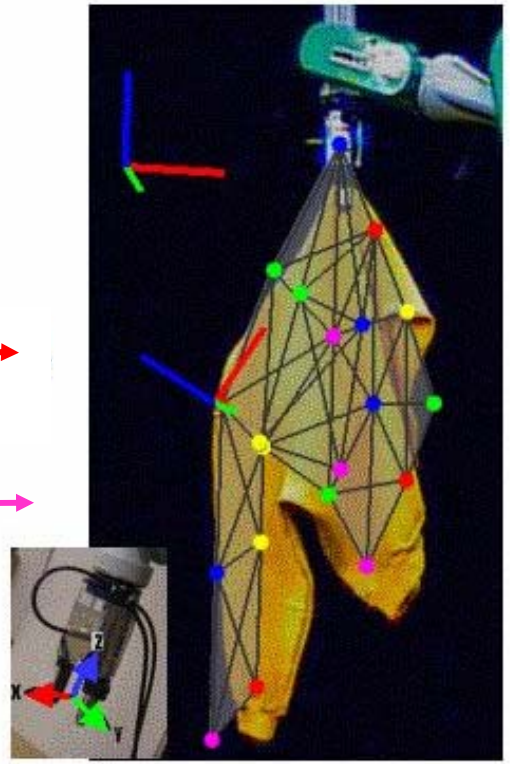


起こりえる形状予測

正しくない予測形状を
初期形状とする場合



観測領域との
一致度評価



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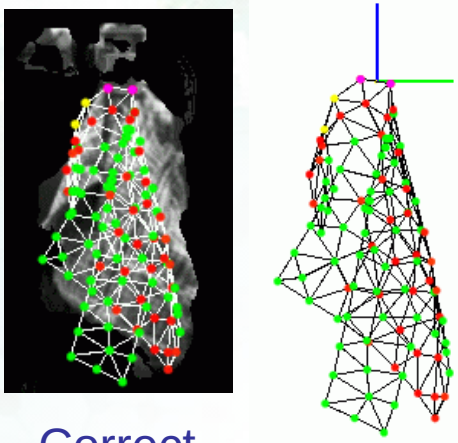
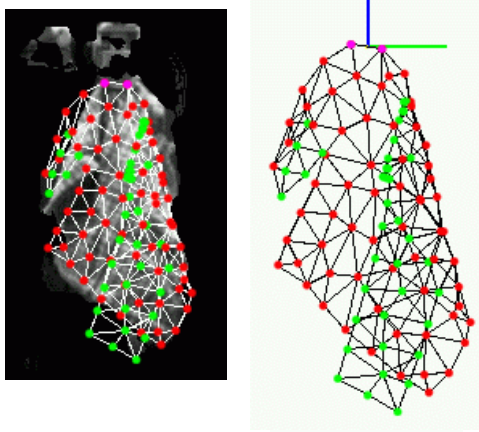
実験2：形状推定への効用



Correct

提案手法で修正後



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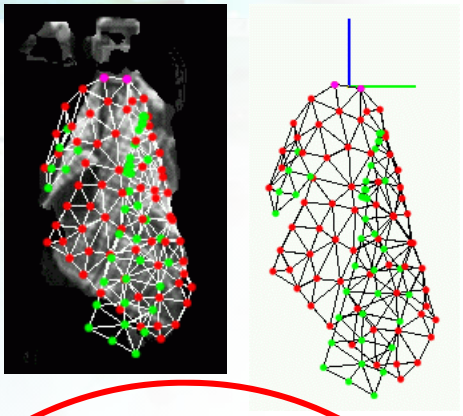
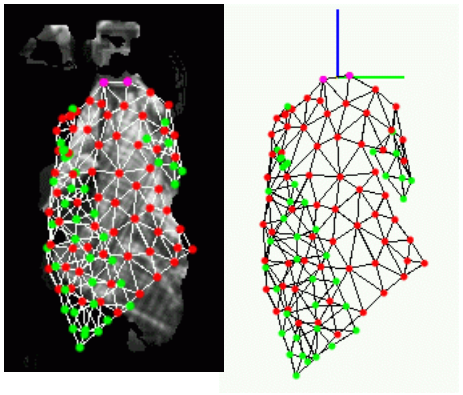
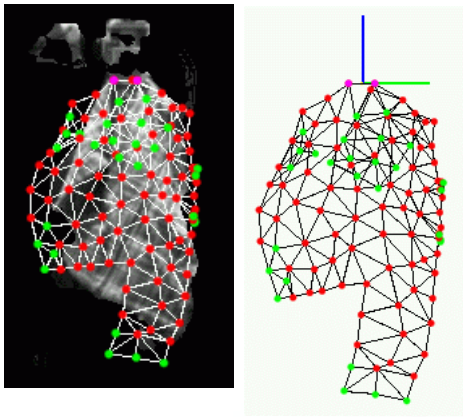
実験2：形状推定への効用



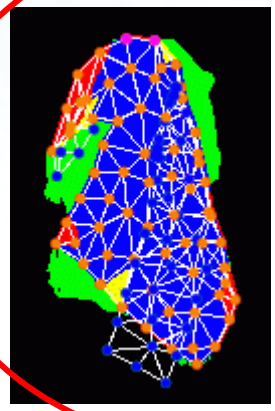




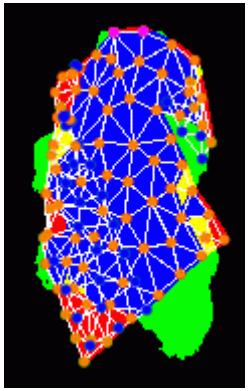
観測領域

可視モデル領域

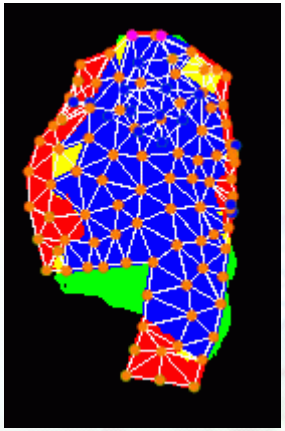
一致領域



R=0.832



R=0.789



R=0.791

領域一致度 R：

$$\frac{\text{観測データ一致領域}}{\text{観測データ領域}} + \frac{\text{観測データ一致領域}}{\text{可視モデル領域}}$$

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まとめ

一点で把持された衣類の予測形状を、観測3次元データに基づき修正することにより、衣類の形状を推定

実データを用いた実験により

1）位置姿勢が既知な把持位置から順次張り合わせるように，予測形状モデルを観測データに一致させていくことにより、安定した形状補正が行える見通し

2）複数の候補形状から正しい形状を選出する際の頑健性向上の見通し

今後の予定

1）得られる情報をもとにハンドリング実験

2）異なる衣類を用いた手法の汎用性実験