3D human motion tracking based on a progressive particle filter

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Challenges

• High Dimensional Representation
  – The large number of degree of freedom (DOF)
  – High computational cost.

• General Unconstrained Motion
  – Non-linear and non-Gaussian
  – Complex

• Self-occlusion

• etc.
Goal

- Reduce the computation cost of human motion tracking
- Improve the recognition accuracy
Human motion is usually non-linear and non-Gaussian, and the particle filter owns the abilities of multiple prediction and lost track recovery
The performance of particle filter is dependent on the number of particles.

- **Huge number of particles**
  - High computational cost
- **Few number of particles**
  - Low accuracy
Progressive Particle Filter (PPF)

I-Cheng Chang and Shih-Yao Lin, "3D Human Motion Tracking based on Progressive Particle Filter," Pattern Recognition, Volume 43, Issue 10, October 2010
Progressive Particle Filter

• Raise the accuracy and recover the false track by multiple prediction
  – Progressive Particle Filter (PPF) uses the random-sampling to predict the multiple hypotheses of human motion.
  – Mean shift trackers shift each particle to the nearby maximum for improving the accuracy

• Reduce the computational cost
  – PPF decomposes the high dimensional space into low dimensional range and samples each particle into low dimensional space for decreasing the computational cost.
Progressive Particle Filter (PPF)

- Raise the accuracy and recover the false track by multiple prediction
  - Progressive Particle Filter (PPF) uses the random-sampling to predict the multiple hypotheses of human motion.
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Comparison

Fig. 14. The angle distributions and error angle distributions of human upper extremities for PPF, PF, and PF_MS: (a) distributions for the left upper arm, (b) distributions for the left lower arm, (c) distributions for the right upper arm and (d) distributions for the right lower arm.
Comparison

Error comparisons for PF, PF_MS, and PPF.

<table>
<thead>
<tr>
<th>Number of initial particles</th>
<th>Mean error (degree)</th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Left upper arm</td>
<td>Left lower arm</td>
<td>Right upper arm</td>
<td>Right lower arm</td>
<td>Total</td>
<td></td>
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<tr>
<td>PF</td>
<td>8.5</td>
<td>24.2</td>
<td>8.5</td>
<td>16.1</td>
<td>14.3</td>
<td></td>
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<tr>
<td>PF_MS</td>
<td>6.1</td>
<td>8.8</td>
<td>5.1</td>
<td>8.0</td>
<td>7.0</td>
<td></td>
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<tr>
<td>PPF</td>
<td>20 × 4</td>
<td>5.9</td>
<td>8.4</td>
<td>7.6</td>
<td>9.4</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Raise the accuracy !!!

Reduce the computational cost !!!