**Background**

3D volleyball trajectory estimation based on monocular vision

- Monocular vision system
- 3D volleyball trajectory

**Proposals**

**Basic framework:**

- Image coordinates sequence
- Simple trajectory model estimation
- Output

- Image coordinates sequence
- Multi-physical factors trajectory model
- Evaluation
- 3D ball trajectory

- Image coordinates sequence
- Self-correcting approximation model
- Evaluation
- 3D ball trajectory

**P3. Spatial and temporal motion state feature based trajectory correction**

- Use events motion feature correct model drifting

**Experiment result**

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Conventional work [1]</th>
<th>Conventional work + P1</th>
<th>Conventional work + P1 + P2</th>
<th>Conventional work + P1 + P2 + P3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error range 150mm [%]</td>
<td>38.3</td>
<td>48.1</td>
<td>74.6</td>
<td>82.7</td>
</tr>
<tr>
<td>Error range 200mm [%]</td>
<td>45.5</td>
<td>53.7</td>
<td>79.8</td>
<td>89.4</td>
</tr>
<tr>
<td>Average error</td>
<td>50.2cm</td>
<td>45.1cm</td>
<td>25.9cm</td>
<td>20.3cm</td>
</tr>
</tbody>
</table>

**Problem**

1. Multi-factors influenced complex trajectory
2. Variable trajectory parameters in flight
3. Model drifting problem in monocular vision

**Solution**

- Proposal 1: Multi-physical factors trajectory model
- Proposal 2: Self-correcting approximation model
- Proposal 3: Spatial and temporal motion state feature based trajectory correction

**P1. Multi-physical factors trajectory model**

- Consider gravity and air resistance in trajectory

\[
P_{x,k+n} = P_{x,k} + V_{x,t} - a V_{x,x} (nt)^2 / 2
\]

\[
P_{y,k+n} = P_{y,k} + V_{y,t} - a V_{y,y} (nt)^2 / 2
\]

\[
P_{z,k+n} = P_{z,k} + V_{z,t} + g(nt)^2 / 2 - a V_{z,z} (nt)^2 / 2
\]

**P2. Self-correcting approximation model**

- Evaluate result and rectify model parameters dynamically

**Conclusion**

The ground truth is Cheng’s work result based on multi-view vision system. Proposed methods achieves 89.4% accurate in error range 150 mm, and 82.7% in error range 200mm