# Motion State Detection based Prediction and Moving Direction Observation for 3D Body Parts Tracking of Volleyball Players

## Research background

**Proposal 3:** Band-width Sobel Observation Model

**Proposal 5:** 3D Distance Constraint Observation Model

## Research target

**Proposal 1:** Motion State Detection based Prediction Model

**Proposal 2:** Cluster Scoring based Observation Model

**Proposal 4:** Torso related Moving Direction Observation Model

**Proposal 2:** Cluster Scoring based Observation Model

## Proposals

### Proposal 1: Motion State Detection based Prediction Model

- **State 0:** Random
- **State 1:** Jump Up
- **State 2:** Keep
- **State 3:** Fall Down

**Merit:** No limit of motion range; Track high-speed motion without fixed templates.

### Proposal 2: Cluster Scoring based Observation Model

- **Target**
- **Prediction**
- **Observation**

**Merit:** Avoid huge errors. Reduce process time.

### Proposal 3: Band-width Sobel Observation Model

- **Band-width Observation Range**
- **Merit:** Fully utilize the irregular shape feature

### Proposal 4: Torso related Moving Direction Observation Model

- **Reference Vector:** Moving vector
- **Merit:** Make target body parts distinguishable from opponents

### Proposal 5: 3D Distance Constraint Observation Model

- **3D Likelihood**
- **Distinguish left and right limbs**
- **Prevent tracking result from locating on teammates**

## Experiment result

### Evaluation Method

**Success frame:** The side of projected rectangle/circle exactly covers or covers part of the tracking target (at least 2 views)

**Success rate**

| Upper body | 20160 particles | 15.2s per frame |
| Lower body | 13600 particles | 9.9s per frame |

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**Merit:**

- No limit of motion range;
- Track high-speed motion without fixed templates.

**Merit:**

- Make target body parts distinguishable from opponents

**Merit:**

- Fully utilize the irregular shape feature

**Merit:**

- Prevent tracking result from locating on teammates

## Conclusion

Our proposals achieve high tracking accuracy (lower body: success rate reaches 97%; upper body: success rate reaches 87%; 71.7% average improvement for hands) by implementing effective tracking of high-speed, random player motions and distinguishing between body parts of target from similar noises of other athletes.