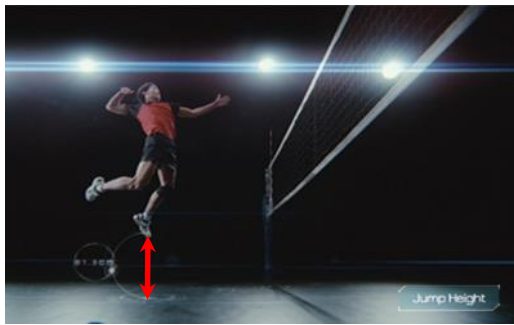
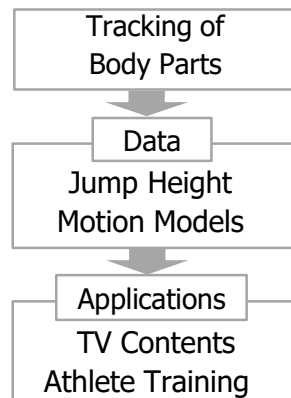


修士課程卒業 謝 芳陸

➤ Research background



<http://www.panasonic.com/jp/corporate/wonders/wondersolutions/kaiseki.html>



Challenges in Tracking of Body Parts

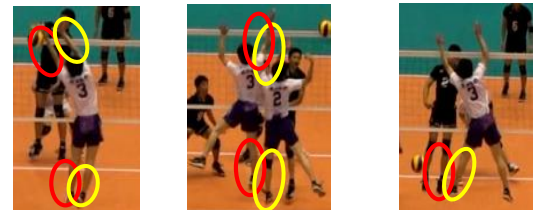
Large motion range of body parts

High-speed and random motions



Interference from other body parts

Similarities between body parts are high
Distances between body parts are small



Self Athlete Different Athlete Opposite Athlete

➤ **Research target**

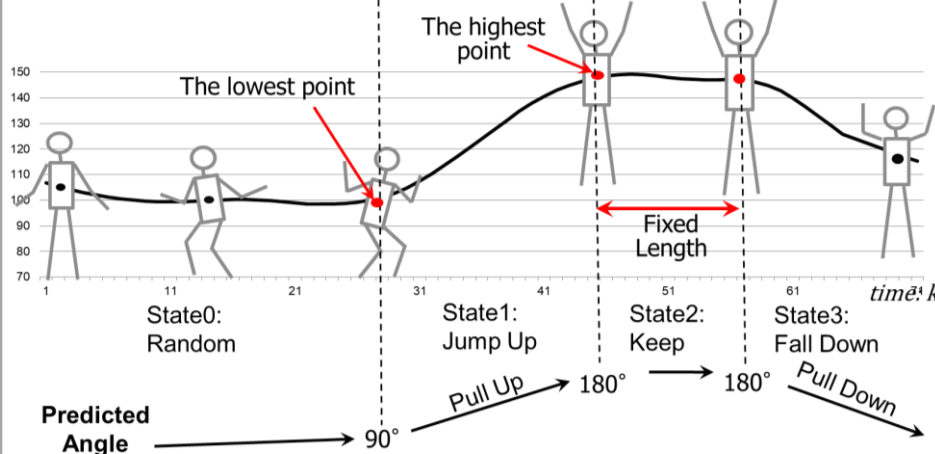
Input: videos from 3 views (block motion)+3D position of torso

Track body parts
in 3D space

Output: 3D positions of hands, elbows, head, shoulders, hips, knees, feet

Proposals

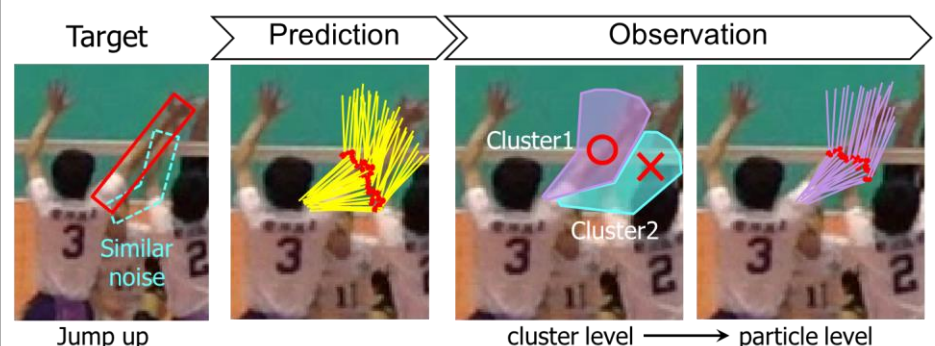
Proposal 1: Motion State Detection based Prediction Model



Merit: No limit of motion range;

Track high-speed motion without fixed templates.

Proposal 2: Cluster Scoring based Observation Model

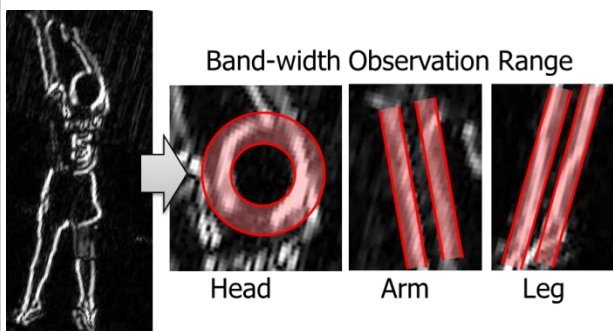


Scores	Cluster1	Cluster2
Ratio of foreground pixels	high	low
Ratio of skin-colored pixels	high	low
Ratio of moving up pixels	high	low
Position of cluster	high	low

Merit:

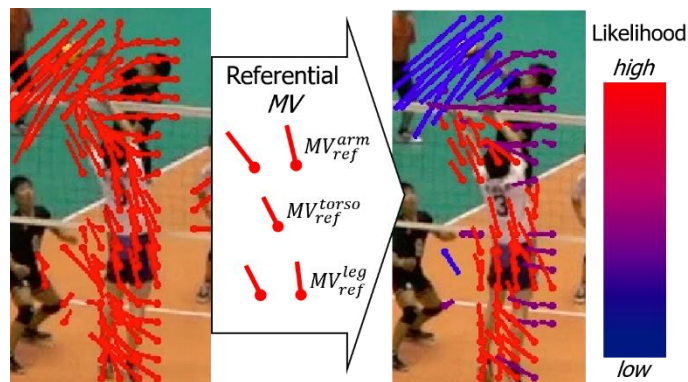
Avoid huge errors.
Reduce process time.

Proposal 3: Band-width Sobel Observation Model



Merit: Fully utilize the irregular shape feature

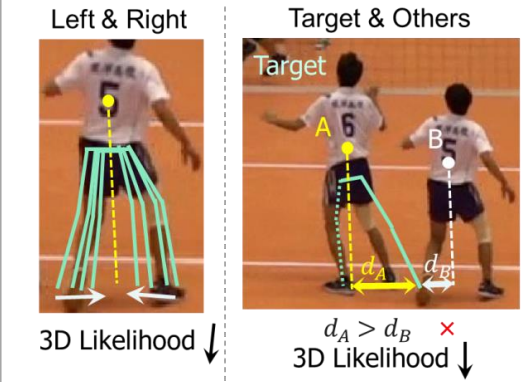
Proposal 4: Torso related Moving Direction Observation Model



MV: Moving vector

Merit: Make target body parts distinguishable from opponents

Proposal 5: 3D Distance Constraint Observation Model



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)

$$\text{Success rate} = \frac{\sum \text{success frame}}{\sum \text{frame}}$$

Upper body	20160 particles		15.2s per frame		Upper: Success rate	Hea d	Shoulders		Elbows		Hands			
Lower body	13600 particles		9.9s per frame				L	R	L	R	L	R		
Lower: Success rate	Hips		Knees		Feet		Framework	77.1	91.9	92.3	38.7	37.1	16.8	15.5
	L	R	L	R	L	R	P1	79.1	93.9	93.2	62.6	68.7	56.3	57.2
Framework	96.2	96.2	87.0	85.6	76.9	74.5	P1, 3, 5	92.6	96.4	96.3	80.0	81.4	77.3	75.4
P3, 5	98.3	98.3	97.5	95.3	97.8	95.0	P1, 2, 3, 5	92.7	96.6	96.3	88.1	89.1	79.7	80.1
P2, 3, 4, 5	98.3	98.3	98.4	98.0	98.1	97.8	P1, 2, 3, 4, 5	92.7	96.6	96.4	91.6	93.8	87.4	88.3

➤ 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 distinguishment between body parts of target from similar noises of other athletes.



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