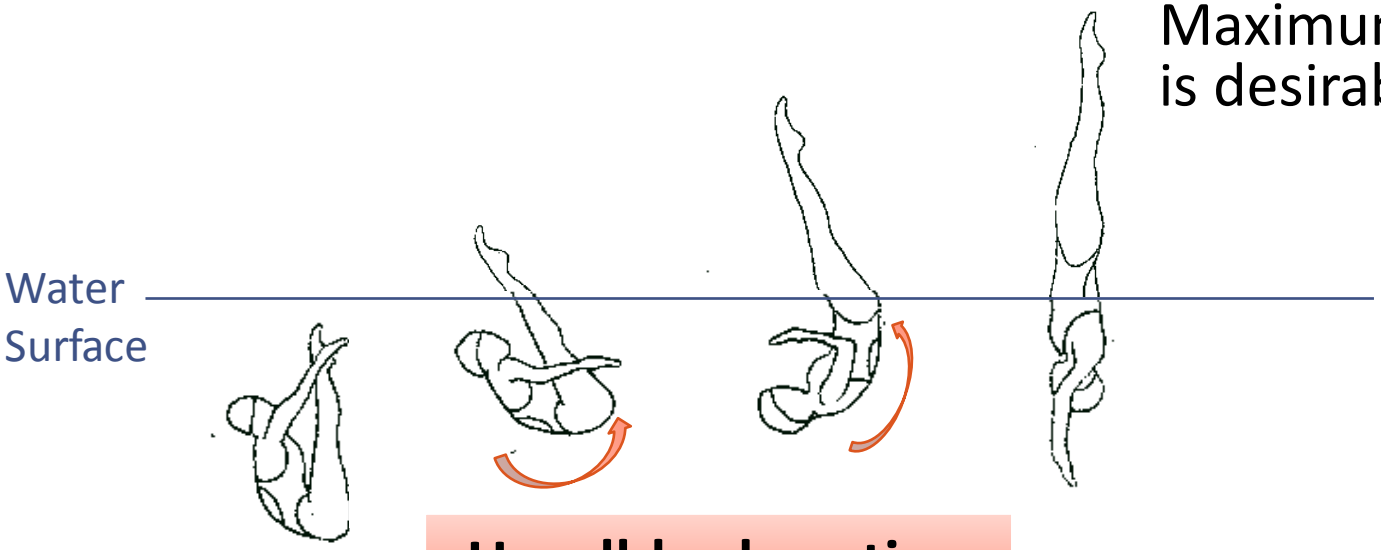
Sculling and unroll-body-action techniques in the thrust movement of synchronized swimming based on 3-D motion analysis

Miwako Homma,
Kanako Nakagawa,
Koji Ito

Thrust movement



Maximum height can be reached by using techniques of unroll-body-action and sculling.

Purpose

To clarify the technical factors for increasing peak height in the thrust movement through the use of 3-D motion analysis both under and above water.

Methods

Participants

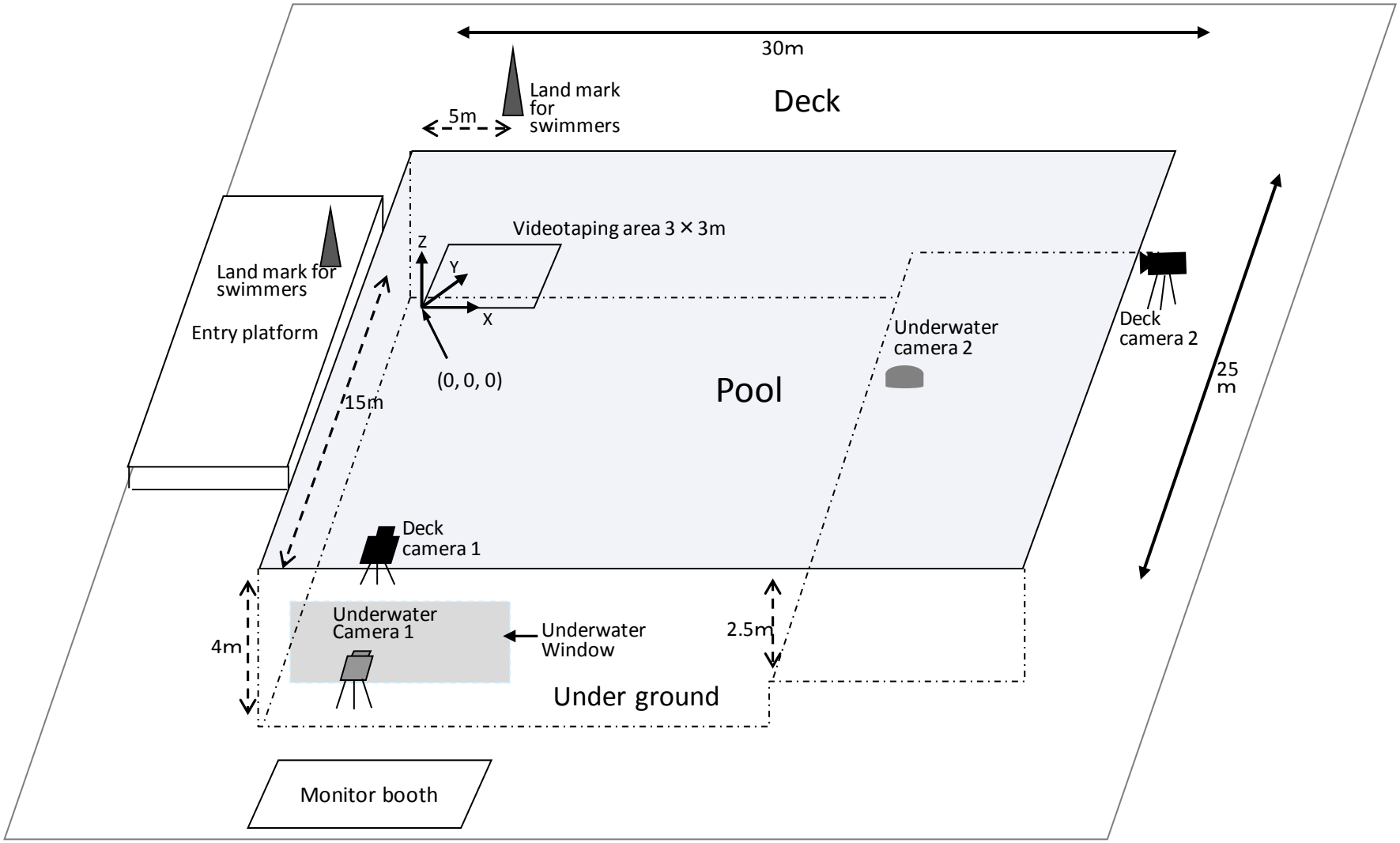
Mermaid Japan

Nine (9) top-ranked synchronized swimmers

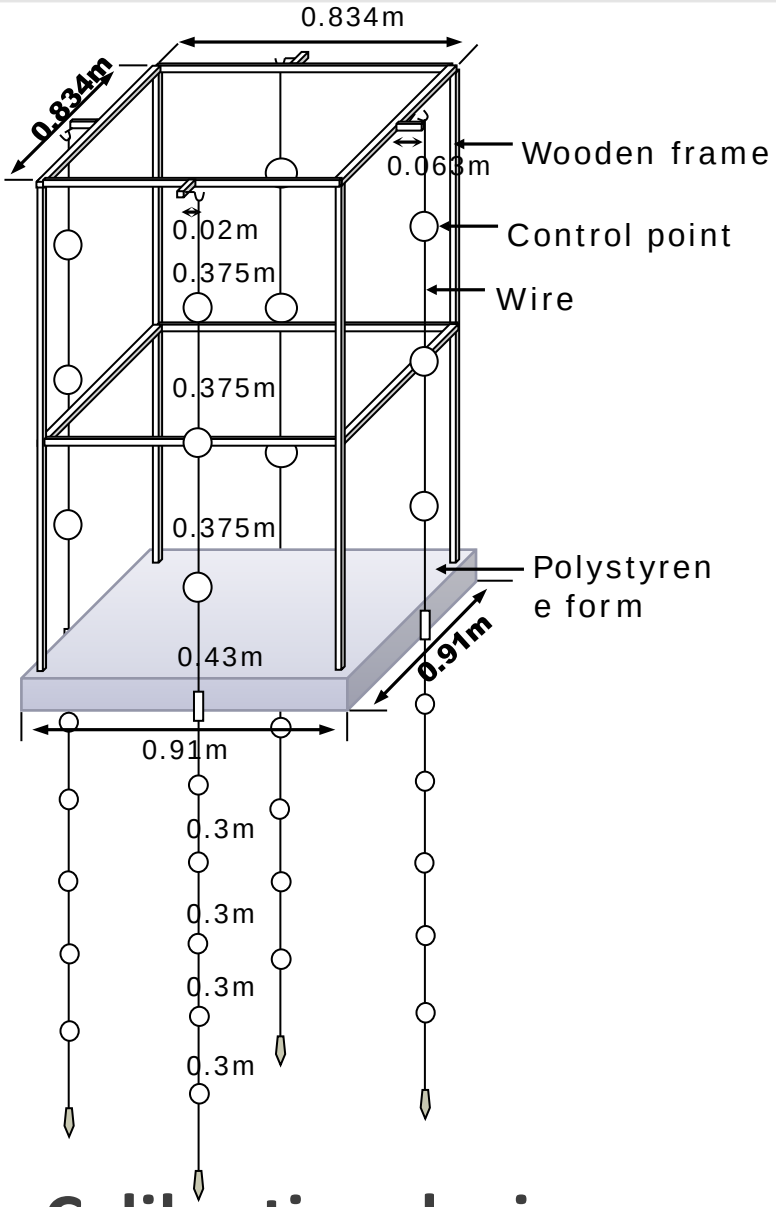
age years	19.9 ± 3.06
height	1.61 ± 0.04 m
weight	52.5 ± 3.51 kg

Methods

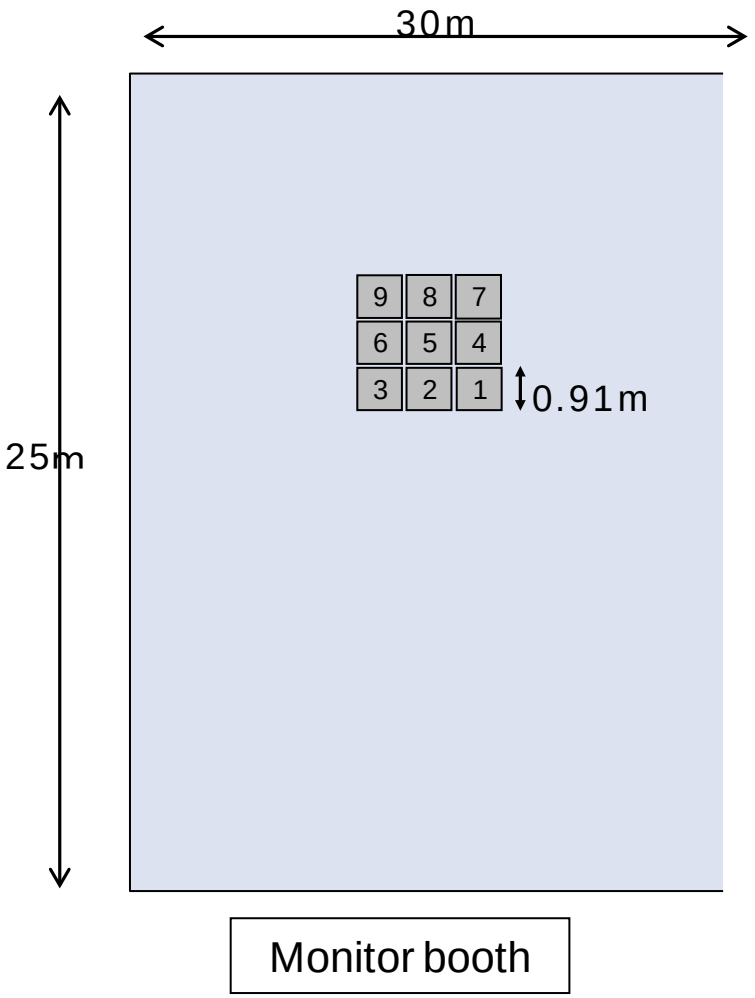
Overview of the experimental set-up



Methods



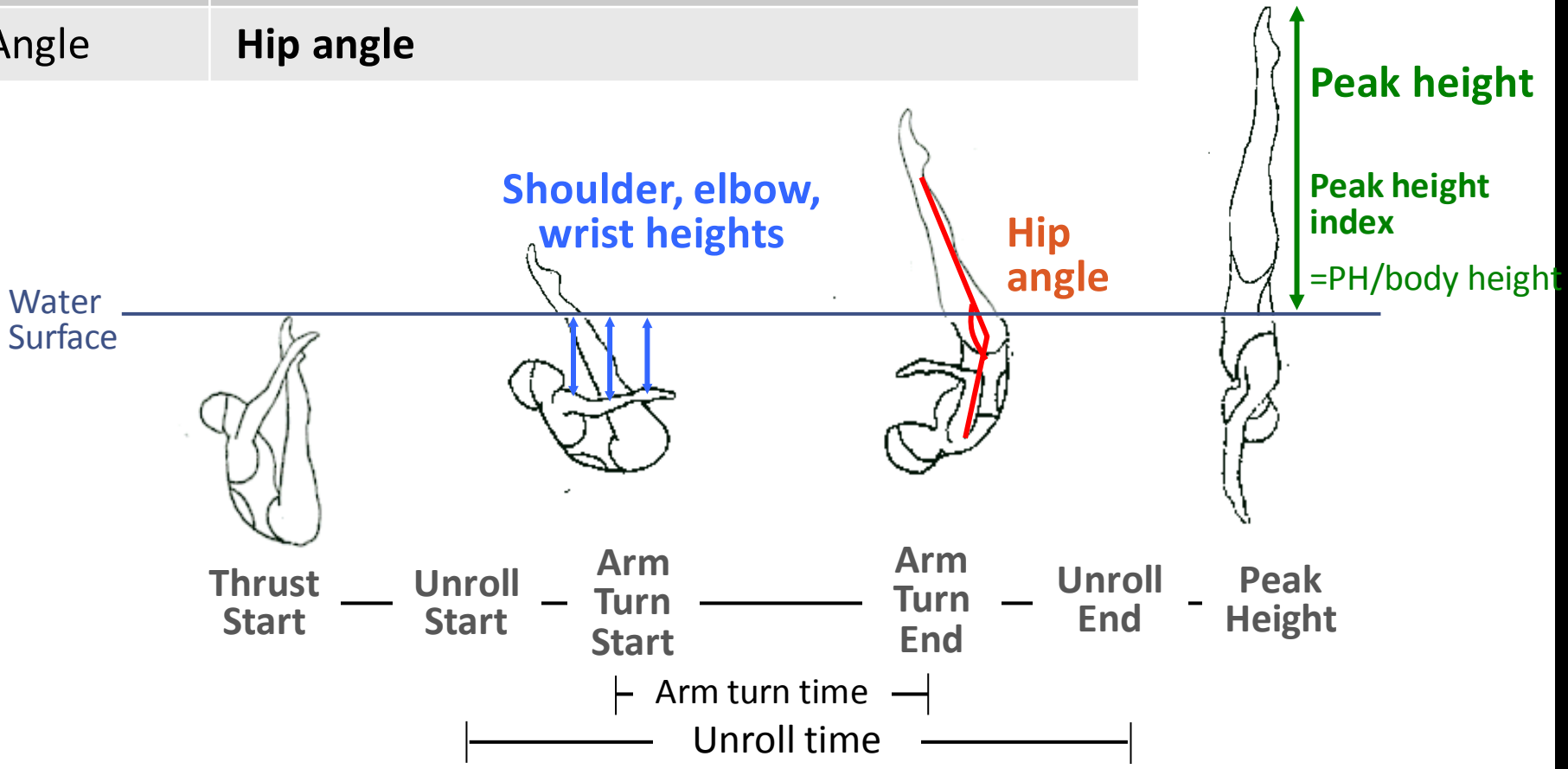
Calibration device



Filming range

Methods | *Kinematic variables*

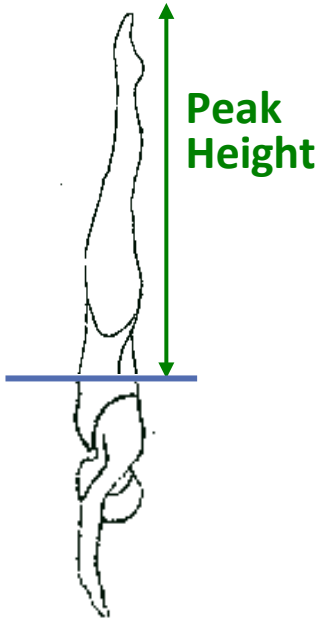
Height	**Peak height (PH), Peak height index (PHI), Shoulder, elbow & wrist heights**
Timing	**Unroll time, Arm turn time**
Velocity	**Vertical velocity of body's Centre of Gravity (CGV), Wrist velocity**
Angle	**Hip angle**



Results & Discussion_1

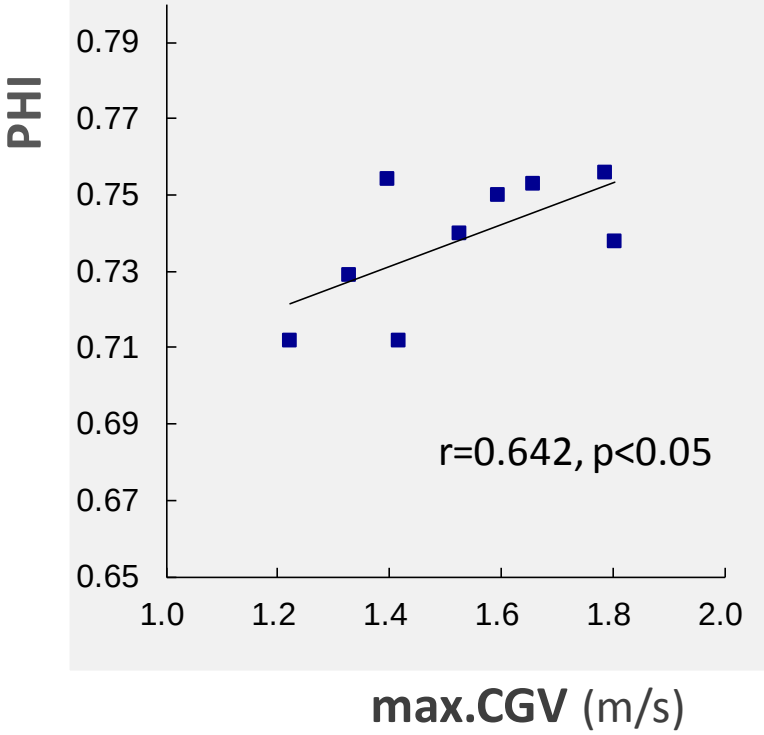
Peak height & peak height index

*PHI = peak height / body height



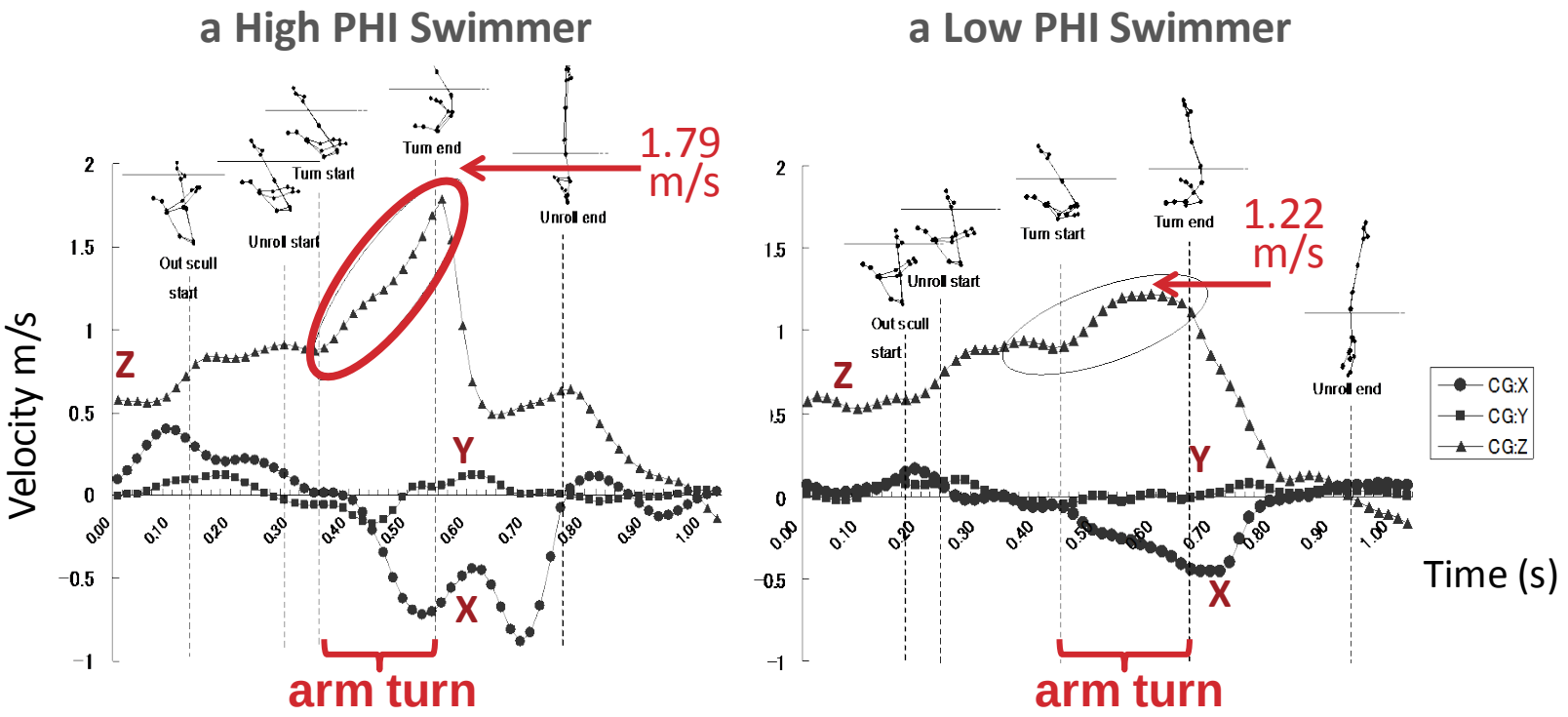
ID	PH (m)	PHI
a	**1.25**	**0.76**
b	1.16	0.75
c	1.23	0.75
d	1.25	0.75
e	1.20	0.74
f	1.15	0.74
g	1.16	0.73
h	1.15	0.71
i	**1.13**	**0.71**
mean	1.19	0.74
sd	0.05	0.02

Relationship between PHI and maximum vertical velocity of body's centre of gravity (max.CGV).



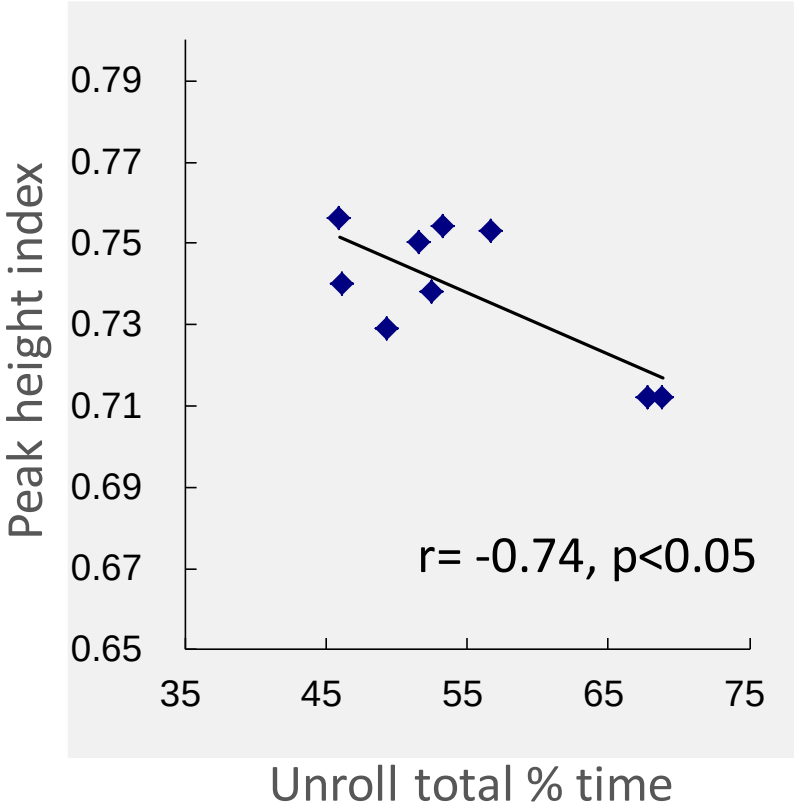
✓ **A significant positive correlation was found between the PHI and the max CGV.**

Changes in velocity of body's centre of gravity



- ✓ Improvement in the max CGV was considered to be one of the most important factors.
- ✓ CGV during arm turn showed a sharp increase in a high PHI swimmer. Sculling is suggested to have an effect on the max CGV.

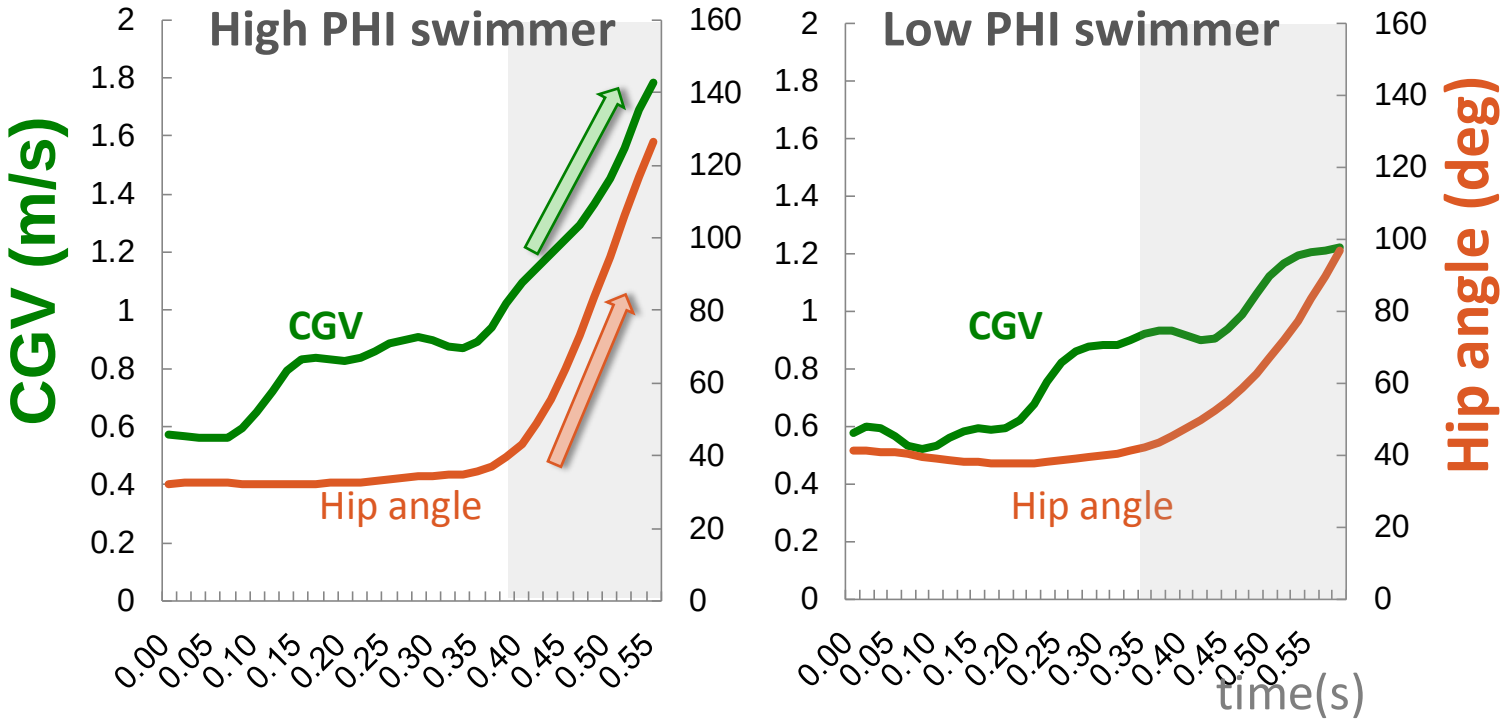
Relationship between peak height index and unroll total %time



- ✓ **As the total unroll time decreased, the PHI showed a tendency to increase.**
- ✓ **Total unroll time was 45.9% time for a high PHI swimmer and 68.9% time for a low PHI swimmer.**

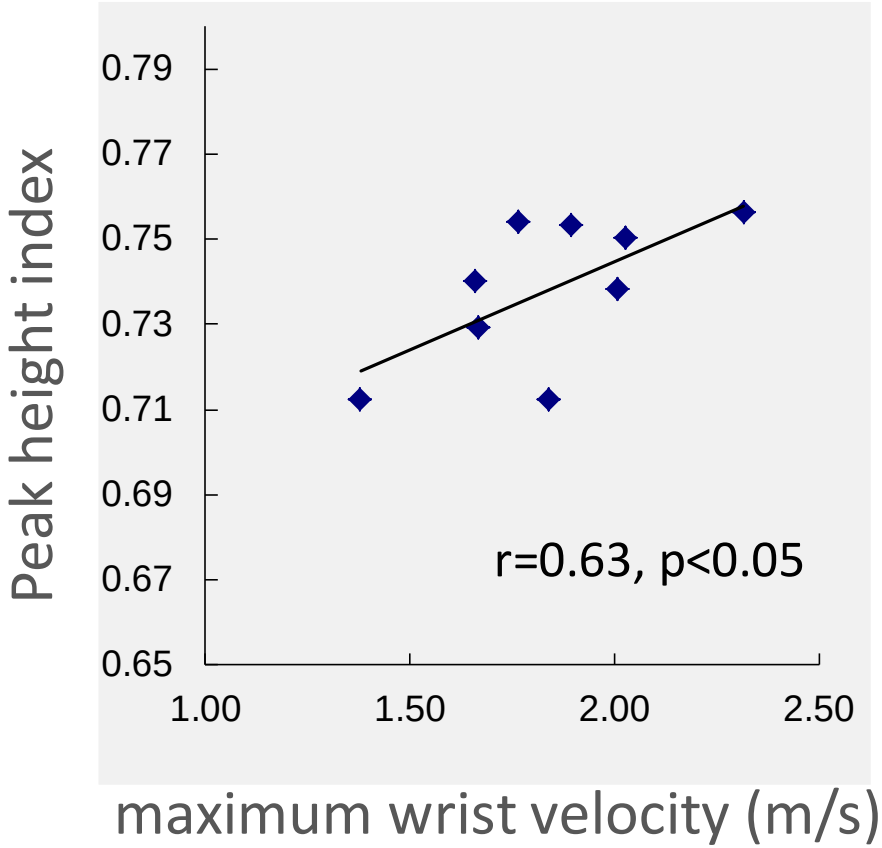
Relationship between hip angle and CGV

from the start of the thrust movement until the max CGV



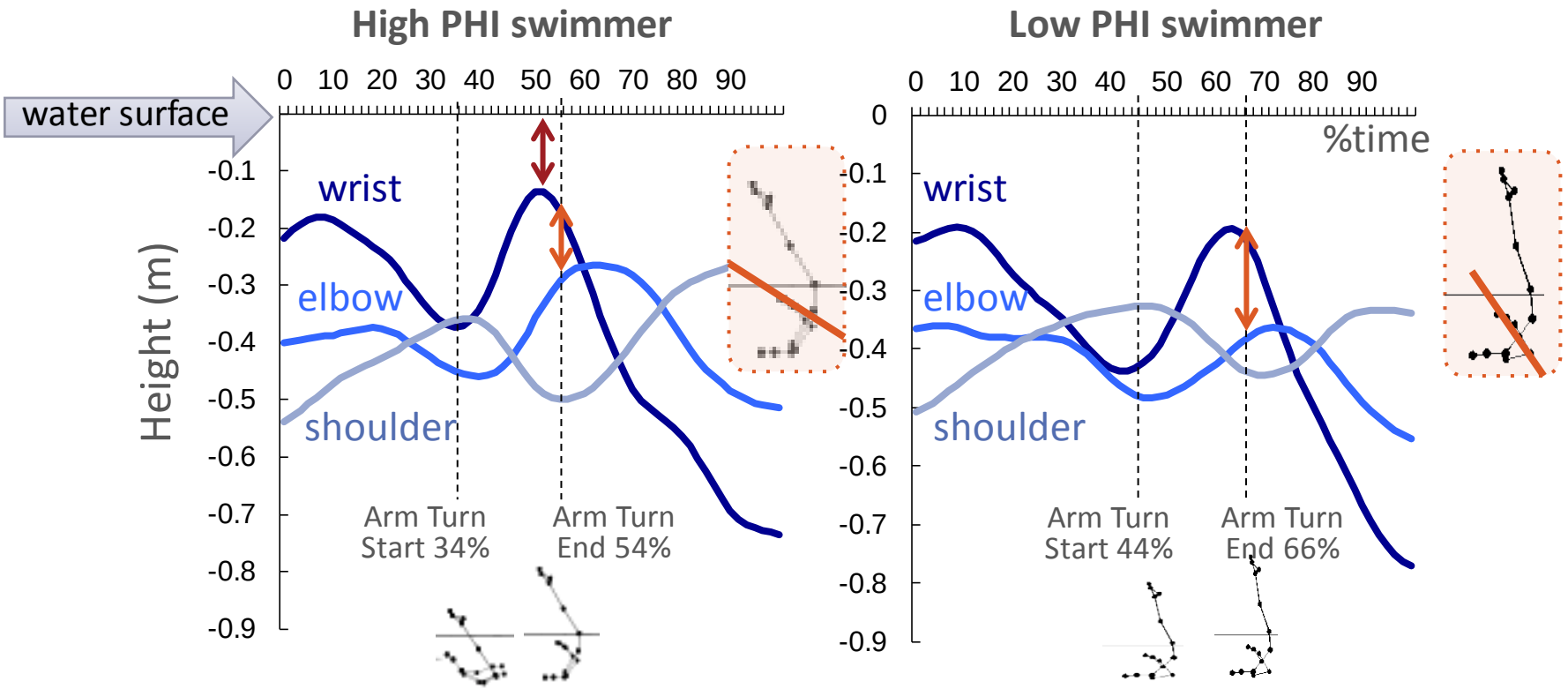
- ✓ **A high PHI swimmer showed large increase CGV with a sharp increase hip angle.**
- ✓ **Unrolling is considered to be effective for increasing CGV and therefore, unroll must be executed sharply and quickly.**

Relationship between peak height index and maximum wrist vertical velocity



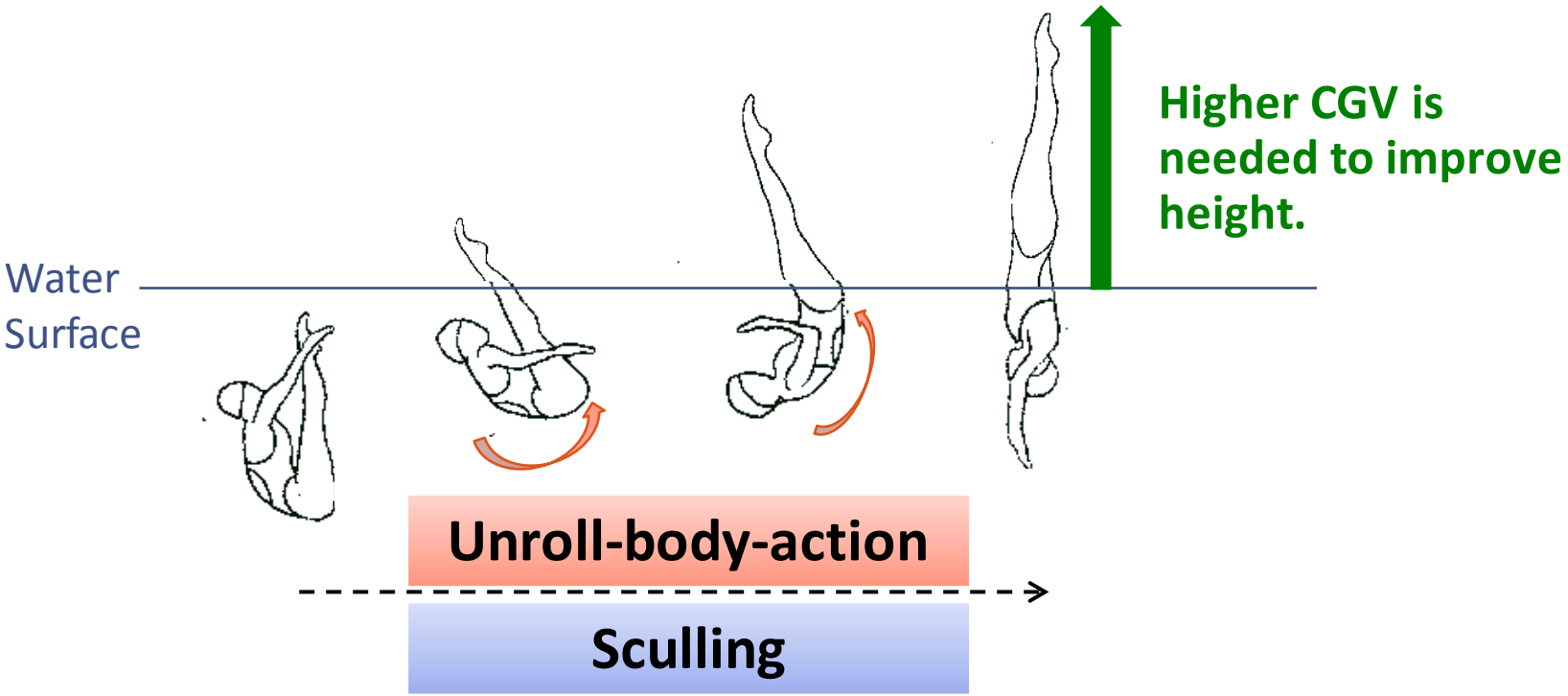
✓ **Maximum vertical velocity of the wrist with quick arm turn technique has an effect on the max CGV.**

Changes in the height of shoulder, elbow, wrist



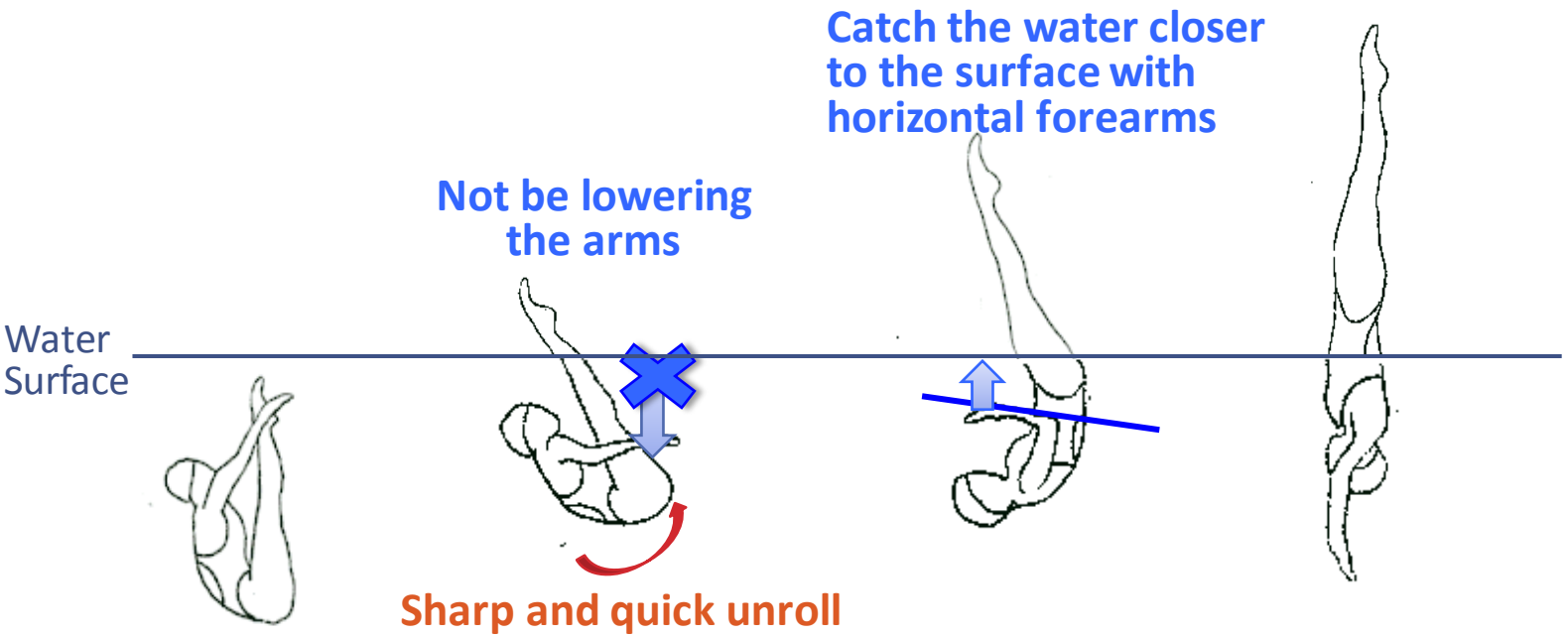
- ✓ **A high PHI swimmer showed higher wrist height at arm turn start and smaller difference between wrist and elbow heights at arm turn end.**
- ✓ **Keeping the position of wrist closer to the water surface during arm turn, and sculling the forearm horizontally are important techniques to increase height.**

Conclusion_1



✓ It is necessary to increase the vertical velocity of the body's centre of gravity in order to increase the peak height, and unrolling and sculling are considered the primary techniques.

Conclusion_2



✓ The important techniques of unroll-body-action and sculling are:

- unrolling must be executed sharply with a quick extension of the hips
- not be lowering the arms at the beginning of thrust movement
- turning the arms rapidly and catching the water closer to the surface with horizontal forearms