The GRASP Taxonomy

The Everyday Action Grasp Taxonomy

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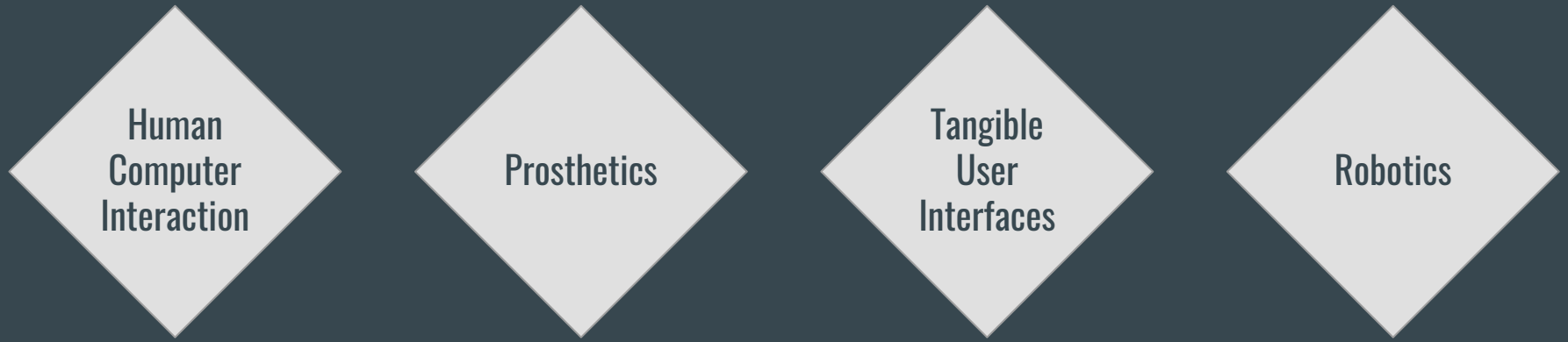
5. November 2020

Motivation



A hand consists out of 15 joints which results in 20 degrees of freedom
Due to this complexity the need for standardization arises

GRASP compares existing Taxonomies to create the most complete

PIP

Power grip

- Strong grip
- Relation between arm and object
- Movement is evoked by the arm

Intermediate grip

- Bridge between power and precision
- Grasps consist out of equal power and precision

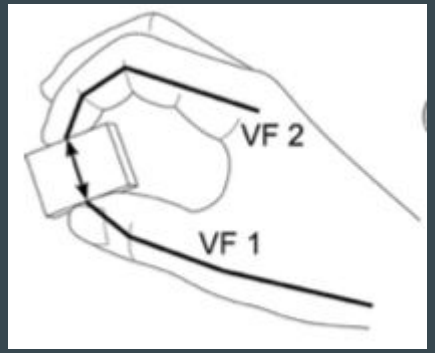
Precision grip

- Well-defined grip
- Relation between hand and object
- Hand can adjust the object without the arm

Opposition Types

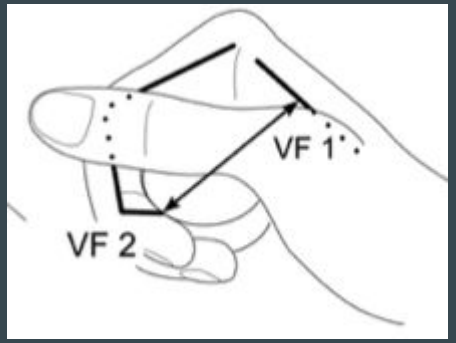
Pad Opposition

Occurs between hand surfaces parallel to the palm



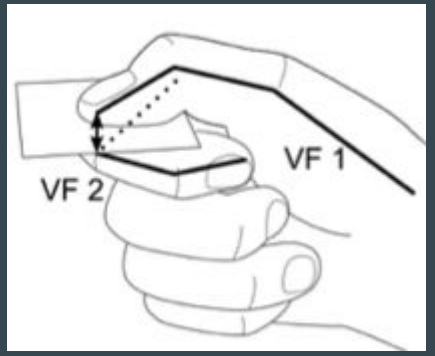
Palm Opposition

Occurs between hand surfaces along a direction perpendicular to the palm



Side Opposition

Occurs between hand surfaces transverse to the palm



Grasp definition and categorization

“A grasp is every static hand posture with which an object can be held securely with one hand, irrespective of the hand orientation”

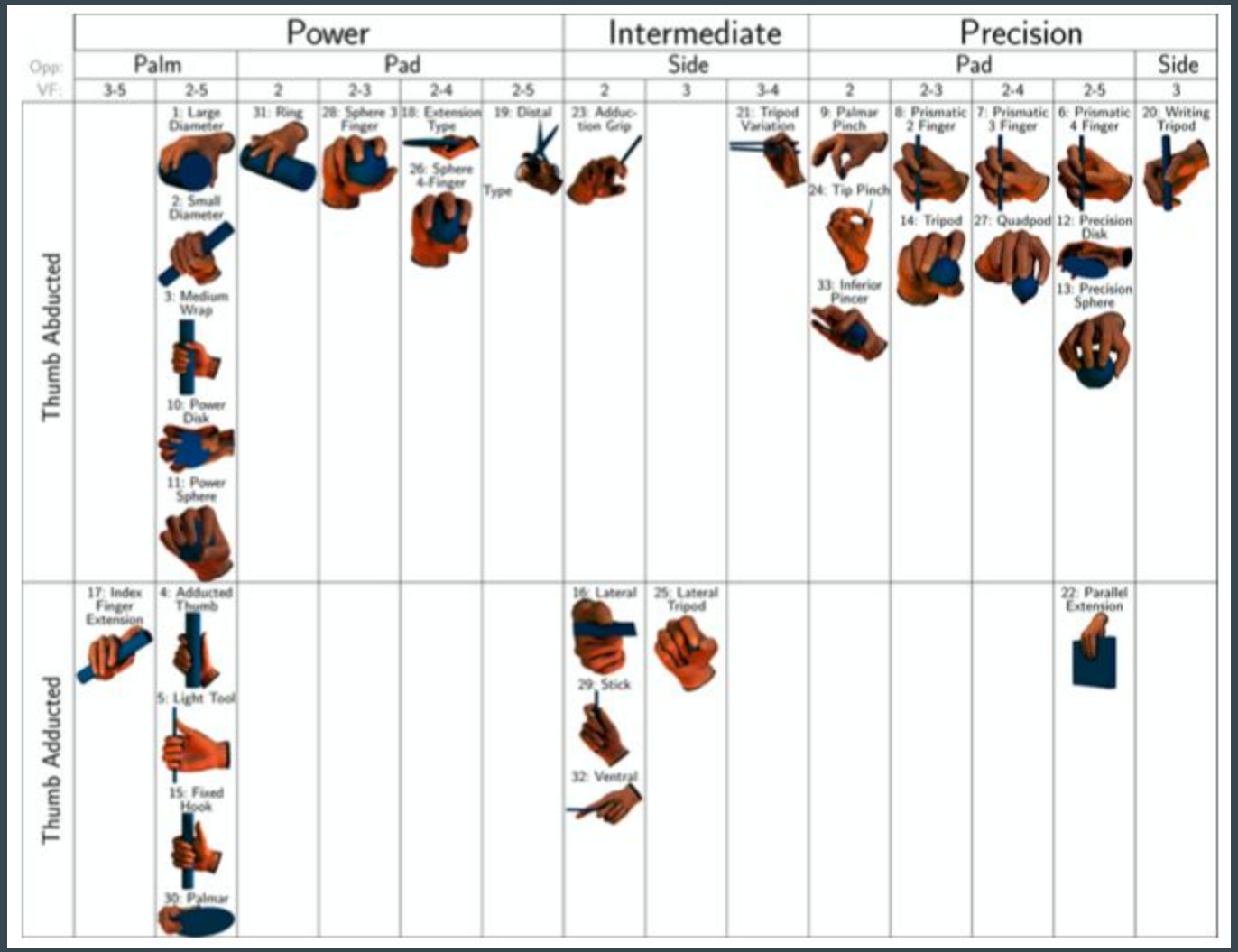
Definition rules out multiple grasps to reduce the complexity of the taxonomy

New Taxonomy Characteristic

(1) Ordered after the PIP scale on the first level
Power and precision are equally present

(2) Ordered after opposition in second level
Opposition defines VF as well

(3) Third level differentiation depends on thumb position
Thumb position is new in the GRASP Taxonomy


Power
Intermediate
Precision
Opp:
Palm
Pad
Side
Pad
Side
VF:
3-5
2-5
2
2-3
2-4
2-5
2
3
3-4
2
2-3
2-4
2-5
3
Thumb Abducted
1: Large Diameter
2: Small Diameter
3: Medium Wrap
10: Power Disk
11: Power Sphere
31: Ring
28: Sphere 3 Finger
18: Extension Type
26: Sphere 4-Finger
19: Distal Type
23: Adduction Grip
21: Tripod Variation
9: Palmar Pinch
24: Tip Pinch
33: Inferior Pincer
8: Prismatic 2 Finger
14: Tripod
7: Prismatic 3 Finger
27: Quadpod
6: Prismatic 4 Finger
12: Precision Disk
13: Precision Sphere
20: Writing Tripod
Thumb Adducted
17: Index Finger Extension
4: Adducted Thumb
5: Light Tool
15: Fixed Hook
30: Palmar
16: Lateral
29: Stick
32: Ventral
25: Lateral Tripod
22: Parallel Extension

Extending the GRASP Taxonomy

The problem: GRASP Taxonomy rules out many everyday grasps

The Taxonomy of Everyday Grasps reintroduces Non-prehensile movement and therefore adds grasps

Example		
Object weight	Light	Heavy
Annotation	Grab an empty box	Hold a heavy box

Many differences in grasps were not considered

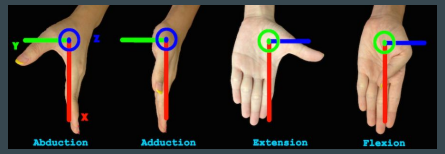
-> Considering *object related factors*

Grasp Features

Hand Shape

-Grasp type

-Thumb position



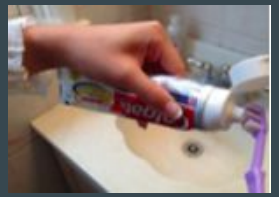
-Opposition type

-Involvement of fingers

-Shape/size of object

Force Type

Internal forces: squeeze, hold



Cumulative forces: throw, grab & press

Grasp Features

Direction

They specify the direction of force or motion

The direction of force can be different from direction of motion

Hand coordinate

Global coordinate

Object coordinate

Flow

Flow is described as an effort factor with the definition:

“attitude toward bodily tension and control”

free — half-bound — bound

casual movement — stiff movement

Benefit of Taxonomies

It is useful for all sorts of computer interaction to have a simple and complete grasp taxonomy that should be standardized to be comparable in different studies