INTERNATIONAL CONFERENCE on COMPUTER SYSTEMS and TECHNOLOGIES
CompSysTech ®

Controlling finger movements of a 3D printed humanoid hand to grasp cylindrical and spherical objects

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ФОНД НАУЧНИ ИЗСЛЕДВАНИЯ
МИНИСТЕРСТВО НА ОБРАЗОВАНИЕТО И НАУКАТА

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Our Goals

- Design and create affordable 3D printed prototype of humanoid hand
- Investigate and develop strategies for grasping objects
- Test the developed hand for grasping spherical and cylindrical objects with different dimensions.

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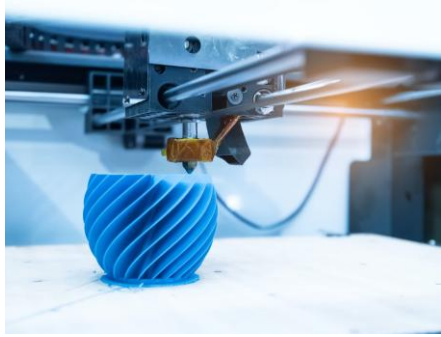
1. Introduction



Why 3D printing technology?

- Allows for custom and individual designs.
- Developing and manufacturing links and joints inspired by nature.
- Allows for the creation of already assembled complex joints and mechanical linkages.

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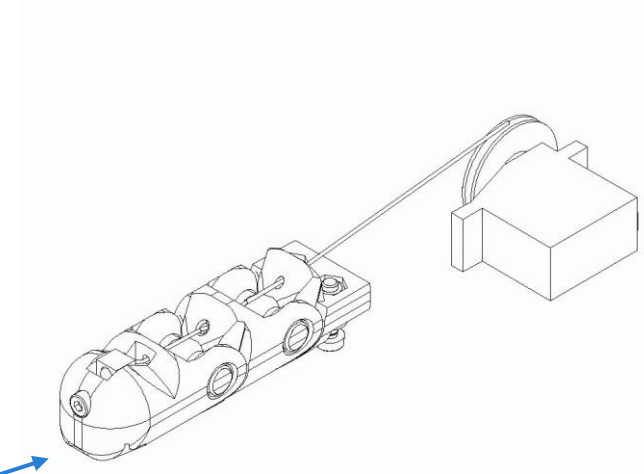
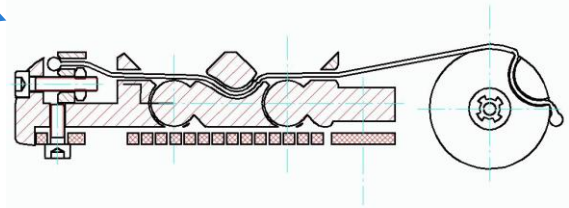
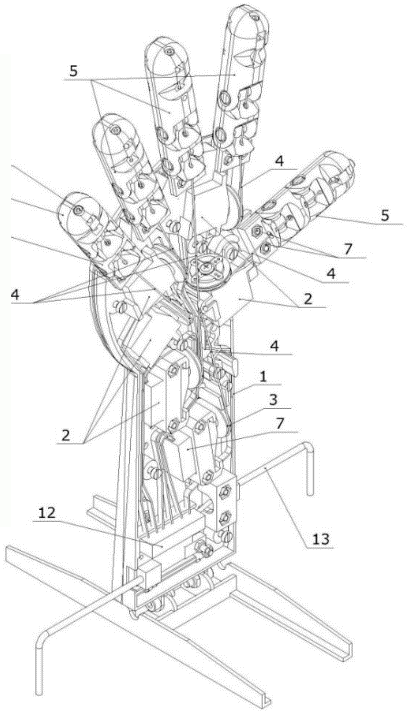
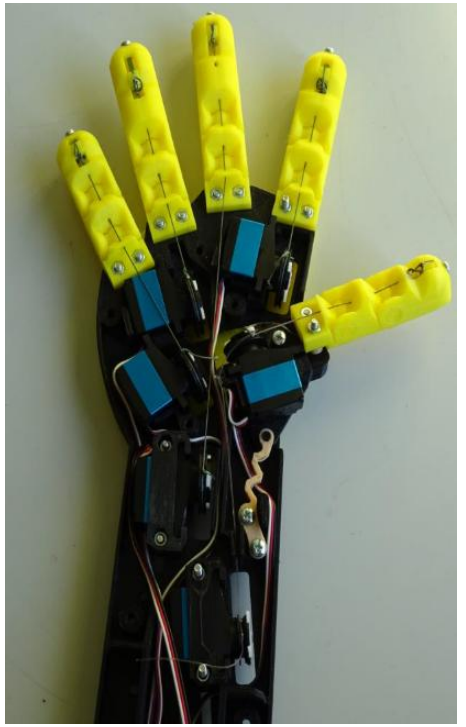
1. Introduction

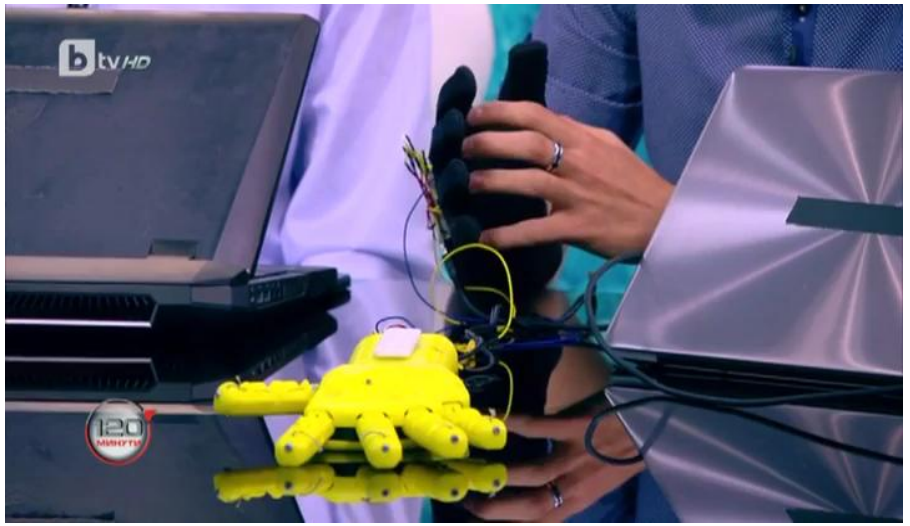
- Creating objects with complex cavities, used for weight reduction, housing components, etc.
- Internal channels for the actuating threads.
- Different strategies for planning, grasping and manipulating objects:
  - With the fingertips
  - With different elements of the fingers and the palm











2. Design of the hand
Design of the modular fingers

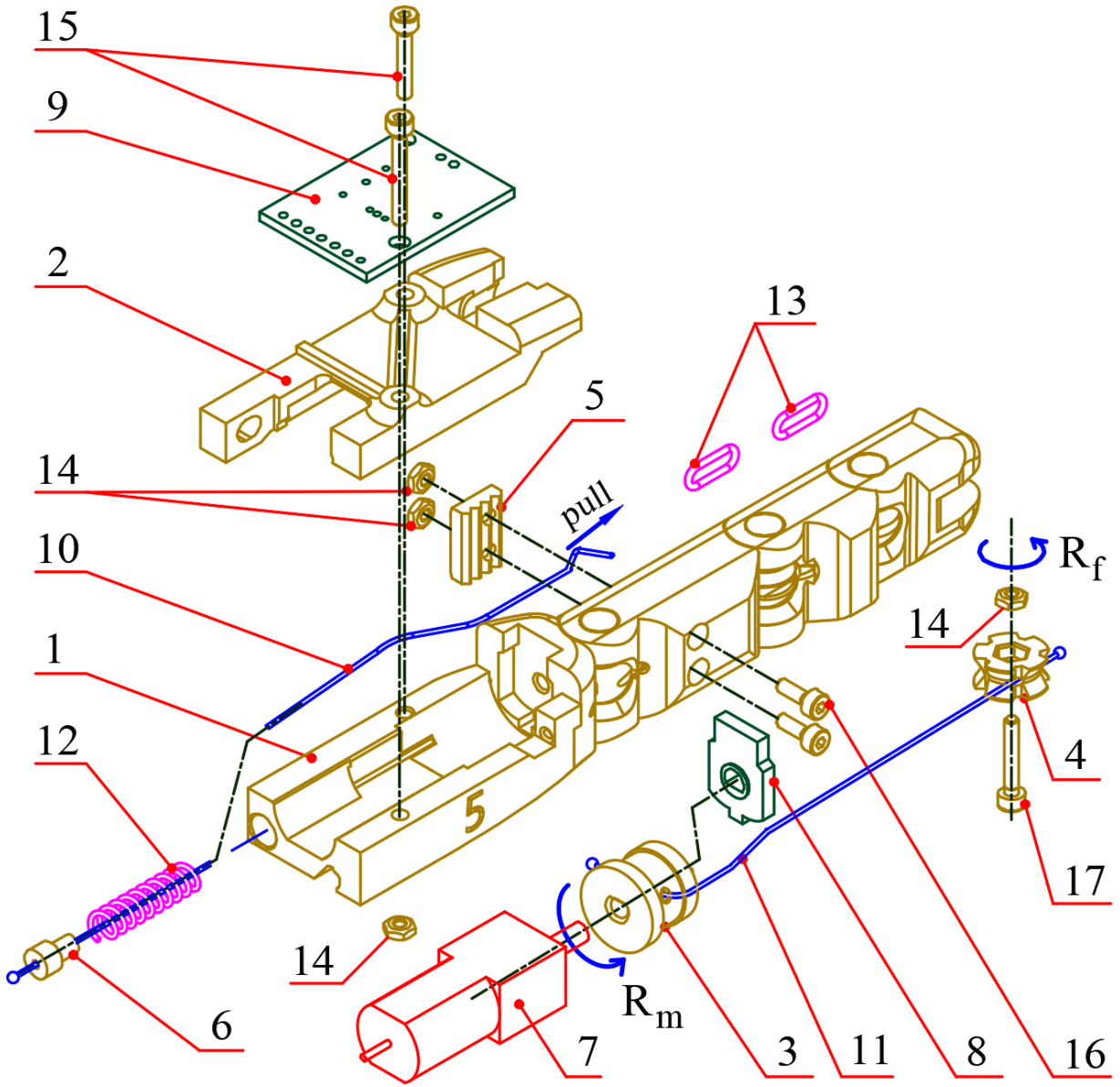


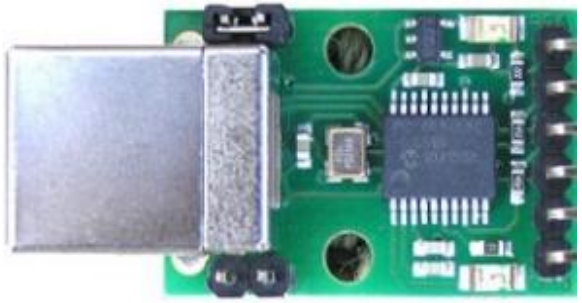
Fig.1. Main components of a finger from the hand: 1- finger body; 2 – lid; 3- driving drum; 4 - tension roller; 5- locking cap; 6- moving spring cap; 7 – gear motor; 8 – potentiometer; 9 - printed circuit board (PCB); 10 and 11 – threads; 12 – spring; 13 – rubber bands; 14 to 17 – fasteners.

2. Design of the hand

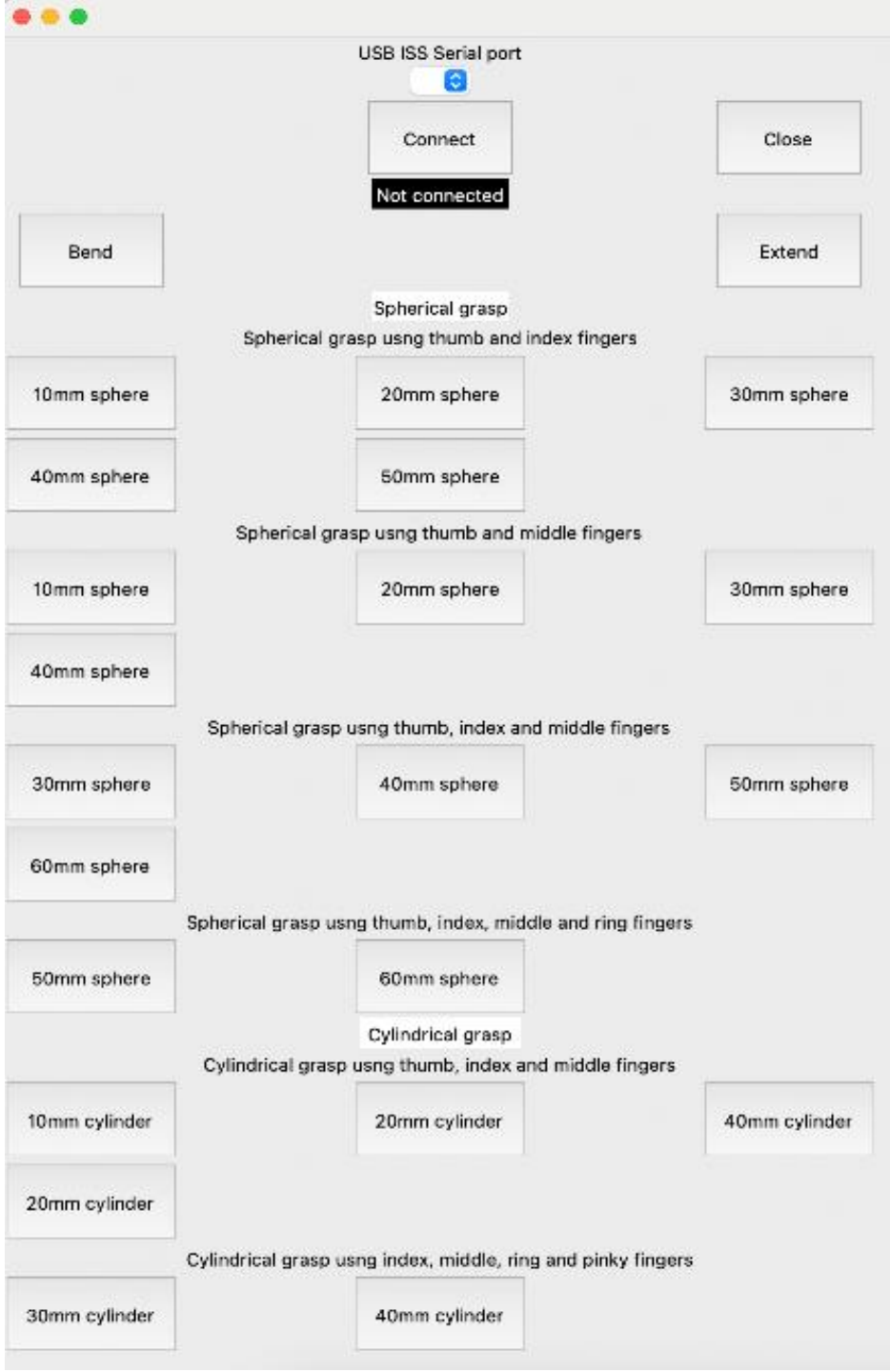
Hardware and Software

- New python software program to control all fingers simultaneously. The main function of the program is to implement spherical and cylindrical grips of objects with a diameter from 10 [mm] to 60 [mm] by using a different configuration of fingers.

- The control electronic module is the same for all fingers, developed on a single-chip Microchip 12F1840 microcontroller. Communication is achieved via I2C protocol, with each finger being an I2C slave module, with a different identifier (slave address).

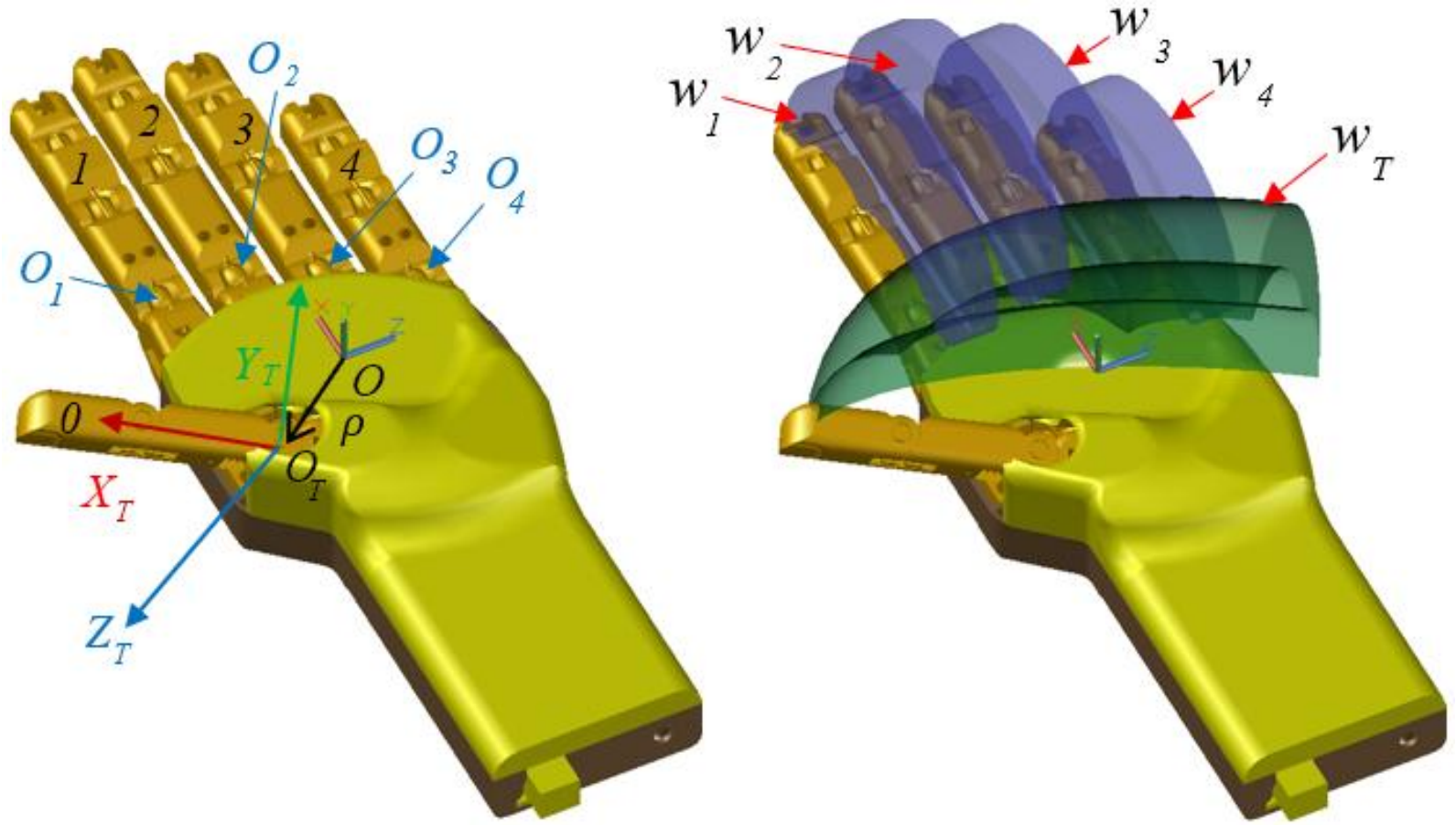


USB-ISS – Multifunctional communication module, mounted on each finger.



3. Analysis of gripping objects with the fingers

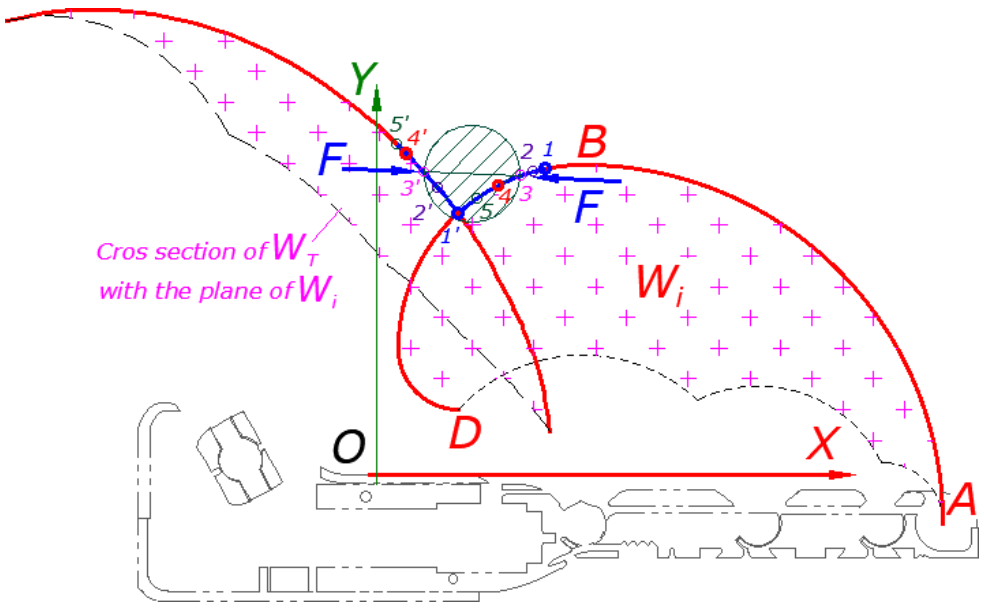
➢ Determining of the working areas of the fingers



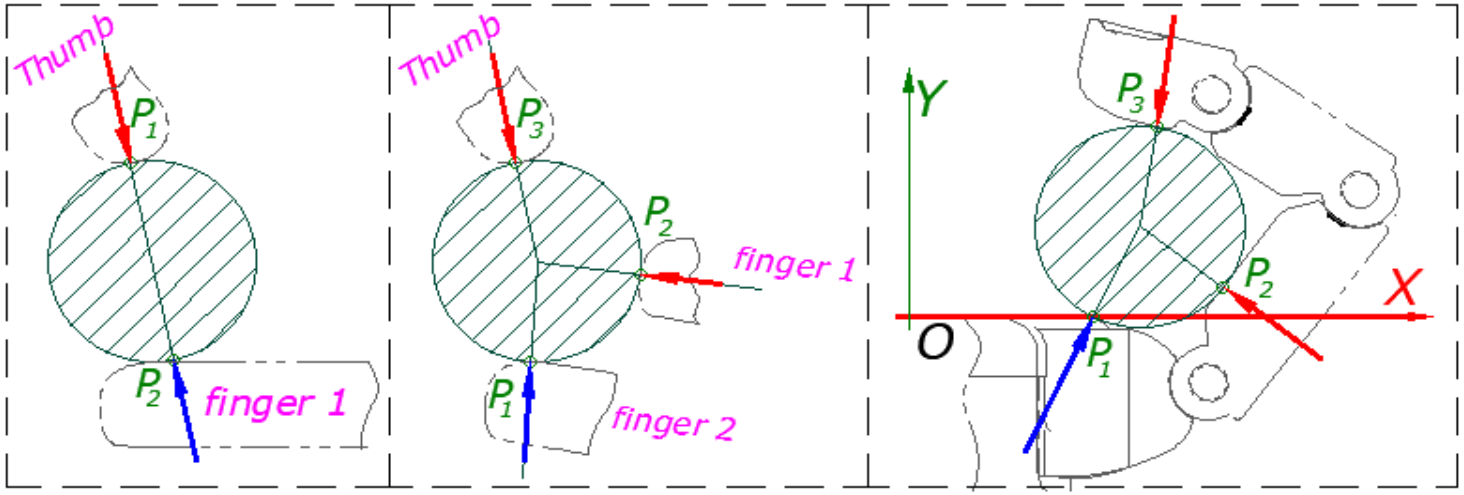
Coordinate systems and 3D model of the working areas of the fingers.

3. Analysis of gripping objects with the fingers

➢ Different grasping approaches of the humanoid hand



Intersection between Object Surface and Finger Workspace



Different strategies for grasping spherical and cylindrical objects:

- with two fingers;
- with three or more fingers;
- with elements of the finger phalanges and the palm.

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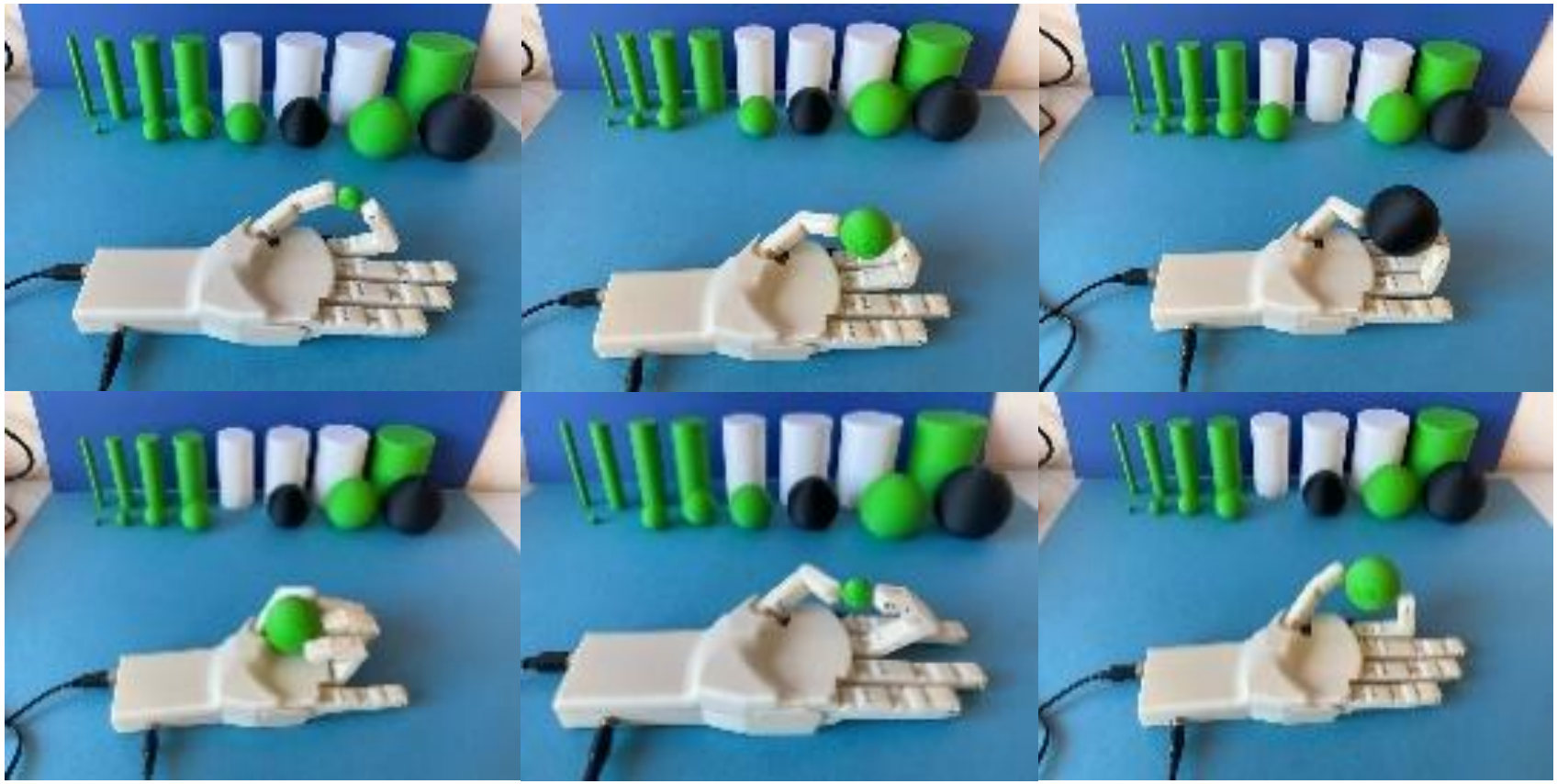
4. Experiments and results

- For the purpose of the experiments spheres and cylinders were 3D printed with diameters from 10mm to 70mm and from 10mm to 50mm respectively.
- Different finger configurations are investigated for both spheres and cylinders.

Grasping different spheres with different number of fingers and strategies.



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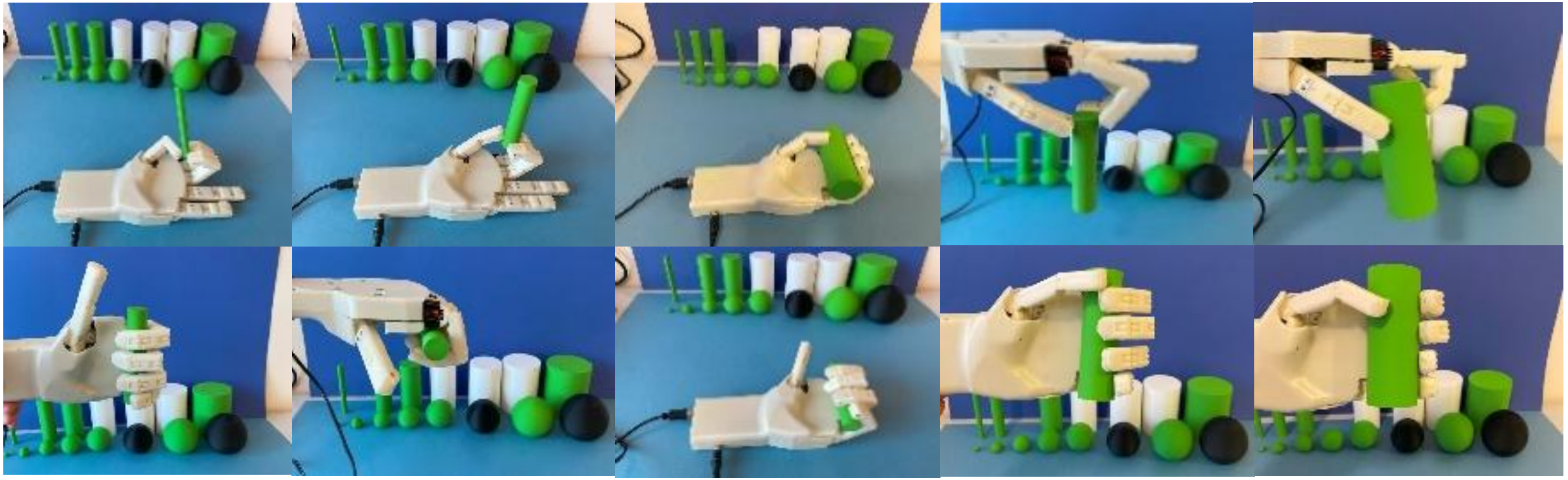
4. Experiments and results

Grasping different cylinders with different number of fingers and strategies.



4. Experiments and results

Encoder values of the different fingers when grasping cylinders.

Diameter [mm]	Fingers used for grasping & Finger position					Orientation
	Thumb	Index	Middle	Ring	Pinky	
10	447	335	404	x	x	V
20	495	435	447	x	x	V
20	x	247	293	388	508	H
30	517	355	405	456	567	H
40	514	428	437	x	x	V
40	488	430	454	531	609	H
50	Cannot be grasped.					

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5. Conclusion and future work

- The developed humanoid hand successfully grasps spherical objects with diameters from 10 to 60 [mm] and cylinders from 10 to 40 [mm].
- The hand is based on modular principle and the fingers are printed already assembled.
- All three considered grasping approaches are verified, using two, three and more fingers and with elements from the phalanges and palm.

Future work:

- possibility to add additional rotation of the thumb;
- Adding tactile resistive sensors on the finger tips to measure the applied force.

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Thank you for your attention!

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