Workshop Unit 8

Teleoperation and Data Collection

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Examples

Da VinciXi Robot

Examples

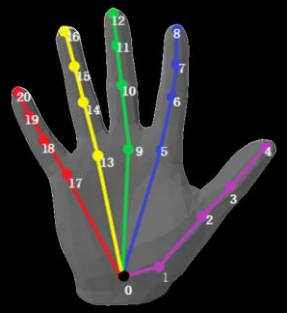
Aloha Robot, Stanford

Examples

Optimus, Tesla

Overview

MANO keypoints



RETARGETER

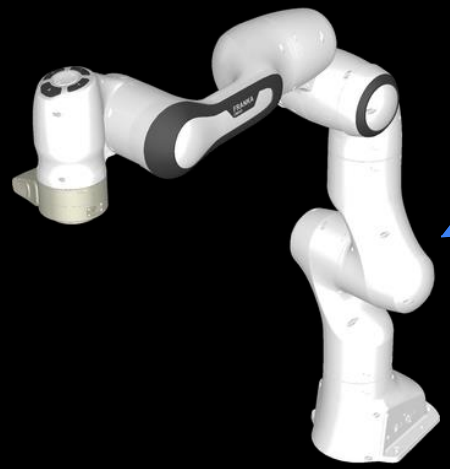
Wrist Pose

Frame Transformation

ETH zürich

SoftRobotics Laboratory

The faive_system structure



INGRESS

RETARGETER

ROKOKO

OAKD

HAND CONTROL

LOGGER

VIZ

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Demo 1 : Streaming Data with the Rokoko Glove + Coil

SCREENSHOT of the windows computer, how to find the IP

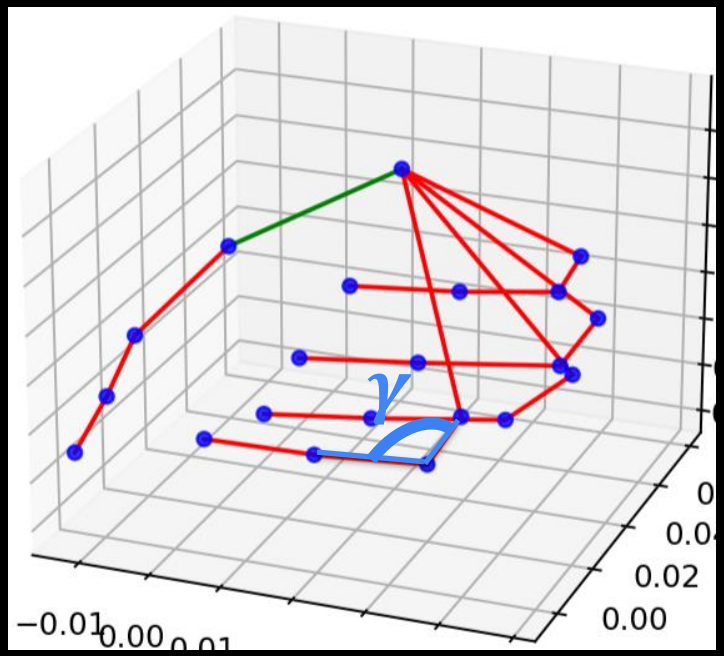
DEMO: Open the rokoko studio app,
Detect Coil and Gloves
Calibrate
Set correct IP and stream the data

Retargeting

Dimension : (21,3)

Dimension : ??

Option 1 : “The Naive”



- Directly take the joint angles from the 3D keypoints
- Direct transfer to the robot hand

PRO

- Easy and straightforward
- Can be useful to quickly test the rom of the joints

CONS

- Not applicable for non-human robot hands
- Fingertips will most likely be not in the "desired spot"

Option 2 : “The Roboticist”

Algorithm 1 Numerical Inverse Kinematics

$\mathbf{q} \leftarrow \mathbf{q}^0$ ▷ Start configuration
while $\|\boldsymbol{\chi}_e^* - \boldsymbol{\chi}_e(\mathbf{q})\| > tol$ **do** ▷ While the solution is not reached
  $\mathbf{J}_{eA} \leftarrow \mathbf{J}_{eA}(\mathbf{q}) = \frac{\partial \boldsymbol{\chi}_e}{\partial \mathbf{q}}(\mathbf{q})$ ▷ Evaluate Jacobian for $\mathbf{q}$
  $\mathbf{J}_{eA}^+ \leftarrow (\mathbf{J}_{eA})^+$ ▷ Calculate the pseudo inverse
  $\Delta\boldsymbol{\chi}_e \leftarrow \boldsymbol{\chi}_e^* - \boldsymbol{\chi}_e(\mathbf{q})$ ▷ Find the end-effector configuration error vector
  $\mathbf{q} \leftarrow \mathbf{q} + \mathbf{J}_{eA}^+ \Delta\boldsymbol{\chi}_e$ ▷ Update the generalized coordinates
end while

From Robot Dynamics Lectures link to notes

Set target pose to fingertip position, then solve numerically with Jacobian pseudo-inverse method

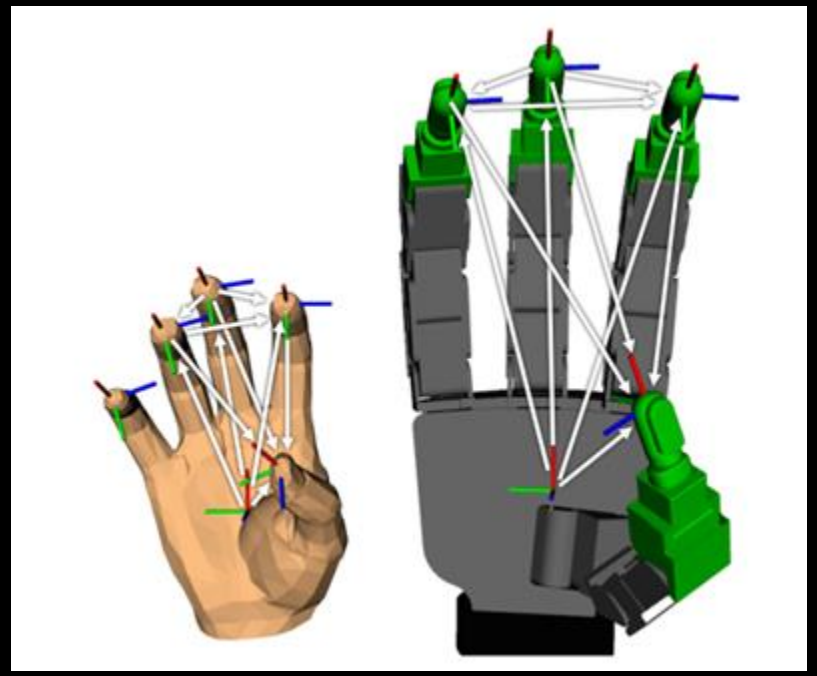
PRO

- Can be very fast (up to 80Hz)
- Accurate fingertip tracking

CONS

- Can fall into numerical instability quite easily

Option 3 : “The ML guy”



Robotic Telekinesis: Learning a Robotic Hand Imitator by Watching Humans on Youtube, 2022
arxiv

- Define keyvectors on the robot and the human hand
- Define Loss function

$$L(q) = \sum_{i=1}^{N} \left\| v_i^h - (c_i \cdot v_i^r) \right\|_2^2$$

Scaling coefficient

Robot joint angles

Hand keyvector

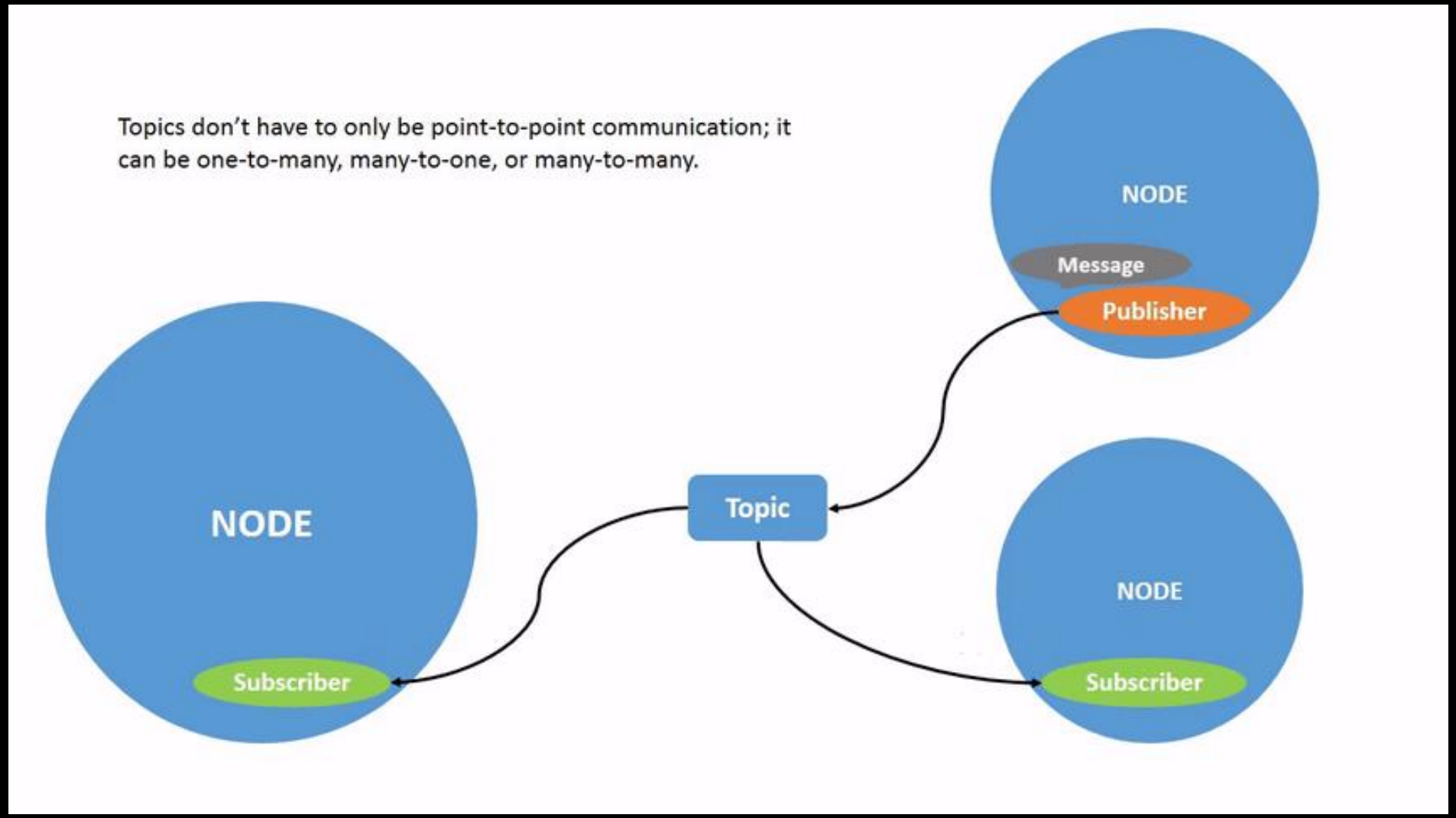
Robot keyvector

- Minimize with gradient descent

Demo 2 : Retargeting

Rviz of the retargeting, change loss parameters and scaling coefficients

Teleoperation : ROS



Teleoperation : rqt_graph

Do it tomorrow

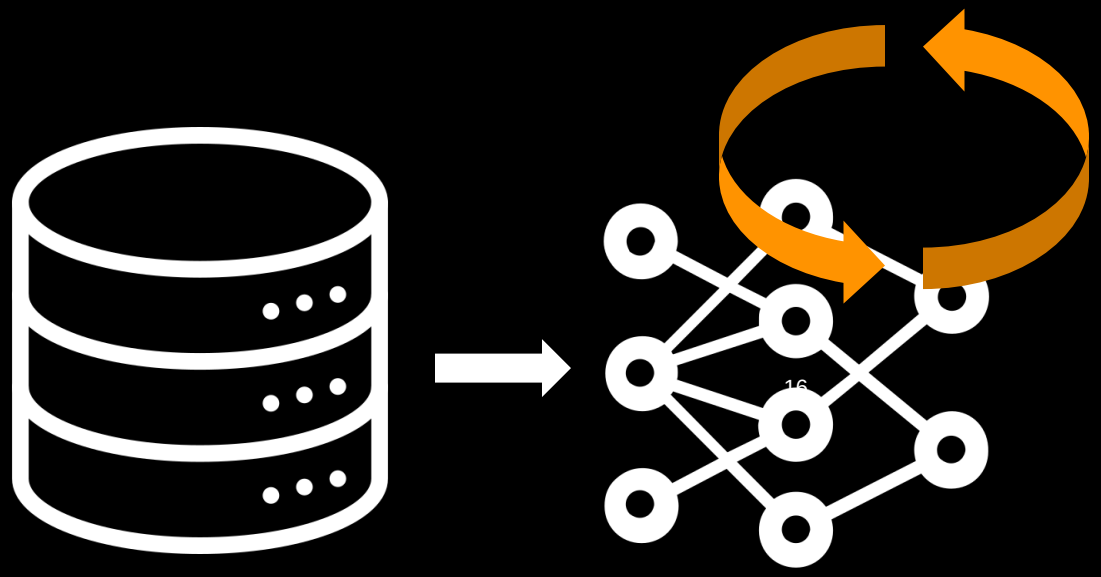
Demo 3: Teleoperation

Like robotX or SRD

Data Collection

Imitation Learning

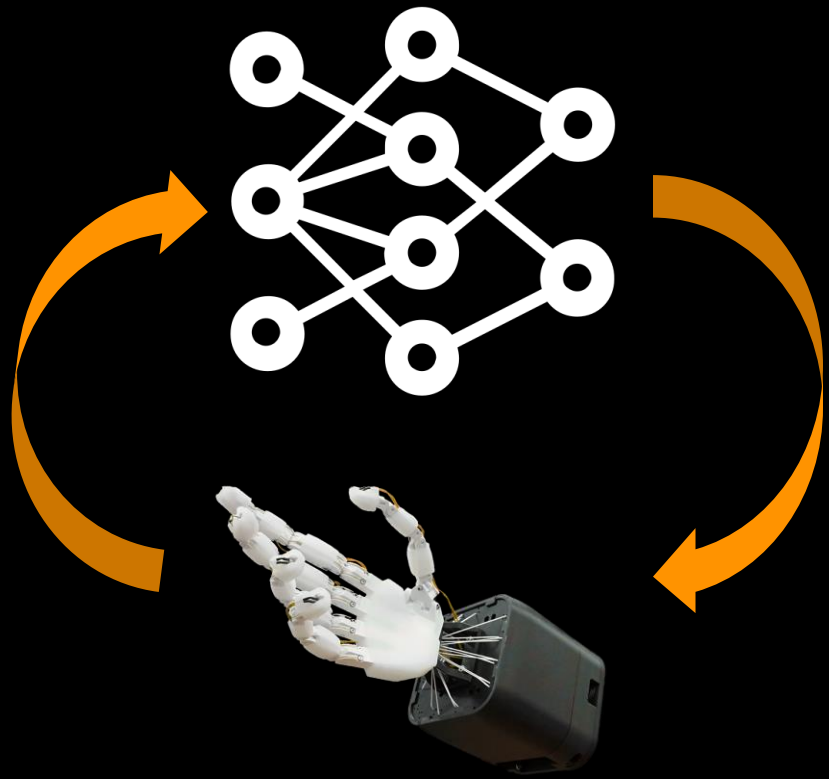
Learn from **expert demonstrations**



Dataset of demonstrations

Train Policy

Deploy on the robot hand



Data Collection

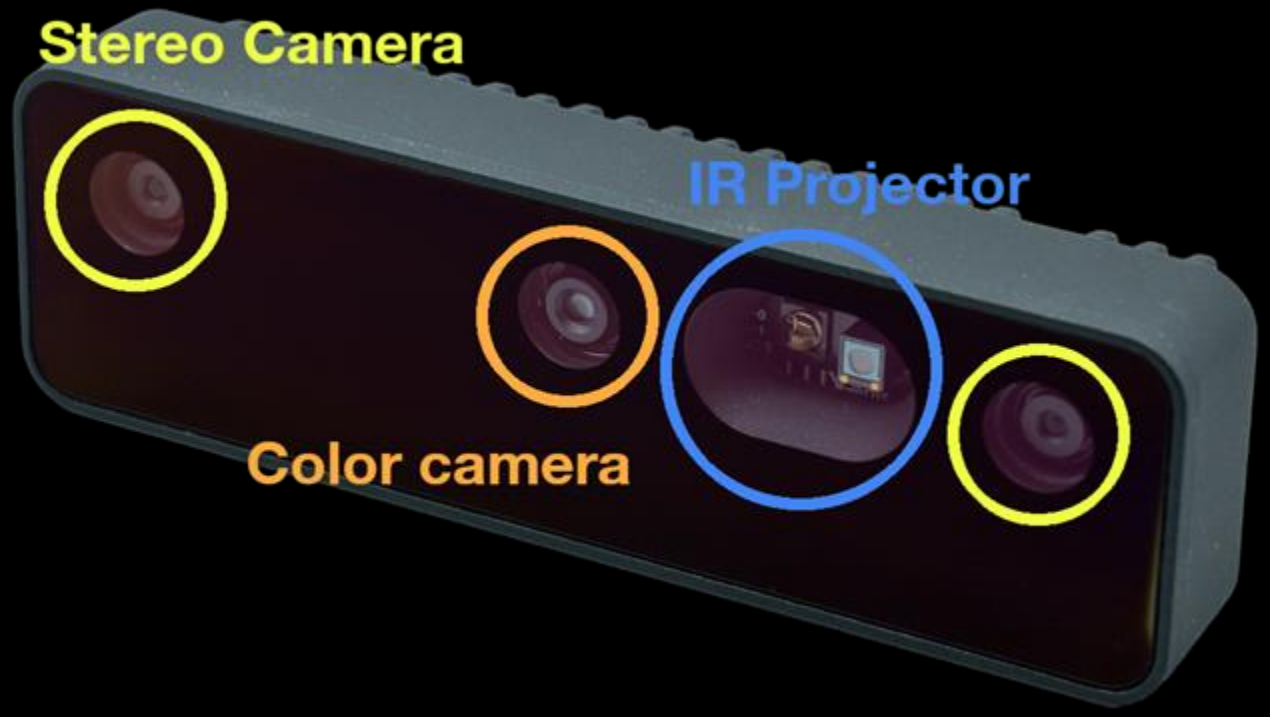
What do we need to record during a demonstration?

- RGB images (Egocentric (wrist), Exocentric (front, side))
- End Effector Pose
- Joint Commands

- ??? (Sensor inputs, point clouds, explicit object tracking, depth, language commands, event annotations, etc..)

Data Collection

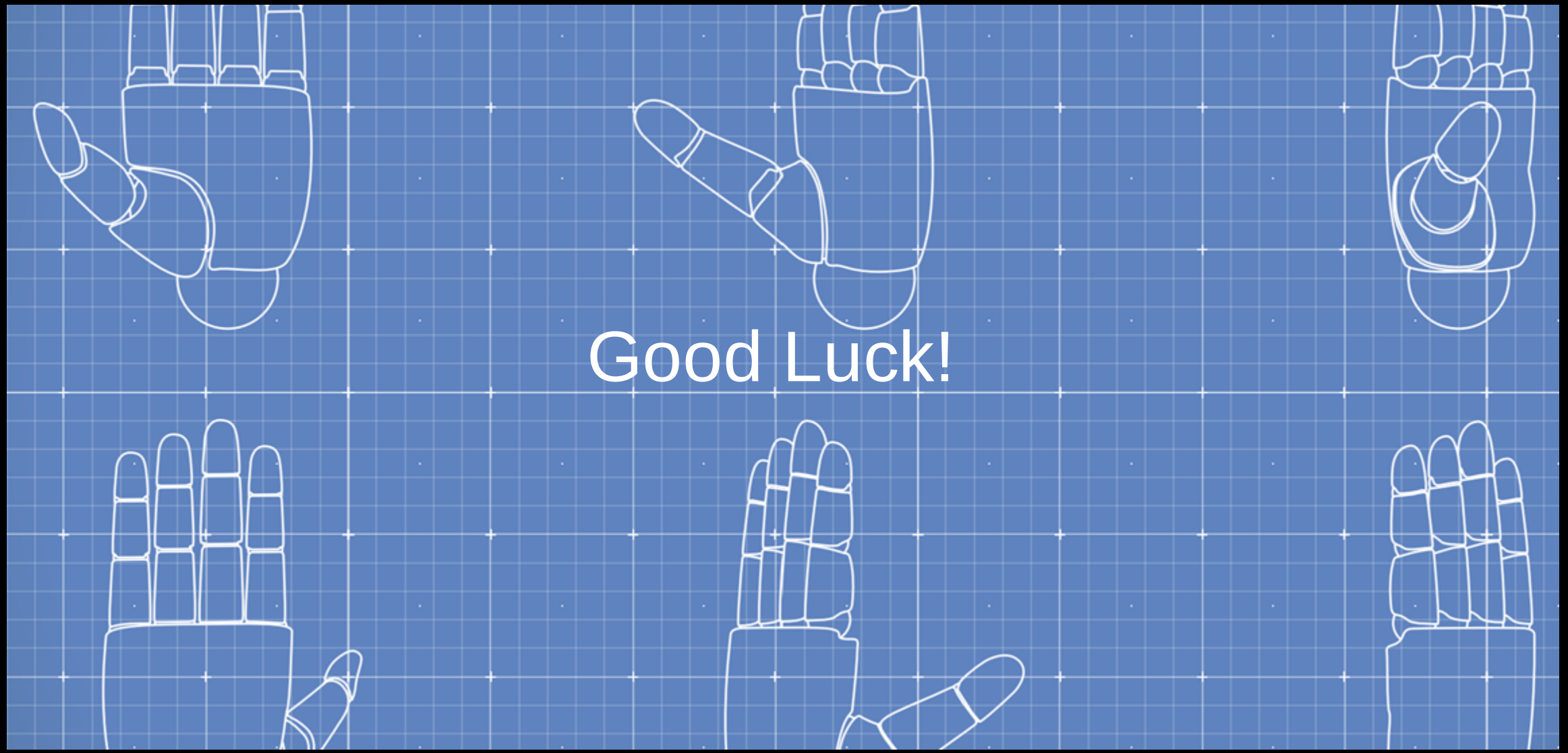
We will use OAKD cameras : Depth, RGB, Stereo



Demo 4: Data Collection

Cube Grasping and dropping with recording

Conclusion - Task overview


Good Luck!