岩手県立大学
ソフトウェア情報学部
Faculty of Software and Information Science
Iwate Prefectural University

ACHI 2021, The 14th International Conference on Advances in Computer-Human Interactions

Assessment of Drug Picking Activity using RGB-D Camera

Yuta Ono and Oky Dicky Ardiansyah Prima

ACHI2021 | July 2021

g236s001@s.iwate-pu.ac.jp

IARIA

■ About Me

- **Name**: Yuta Ono
- **Course**: Ph.D. candidate student
- **Affiliation:** Graduate School of Software and Information Science, Iwate Prefectural University
- **Research of interest**
  - 3D human pose estimation and its application
  - Human activity recognition
  - Human behavior analysis

Iwate Prefectural University

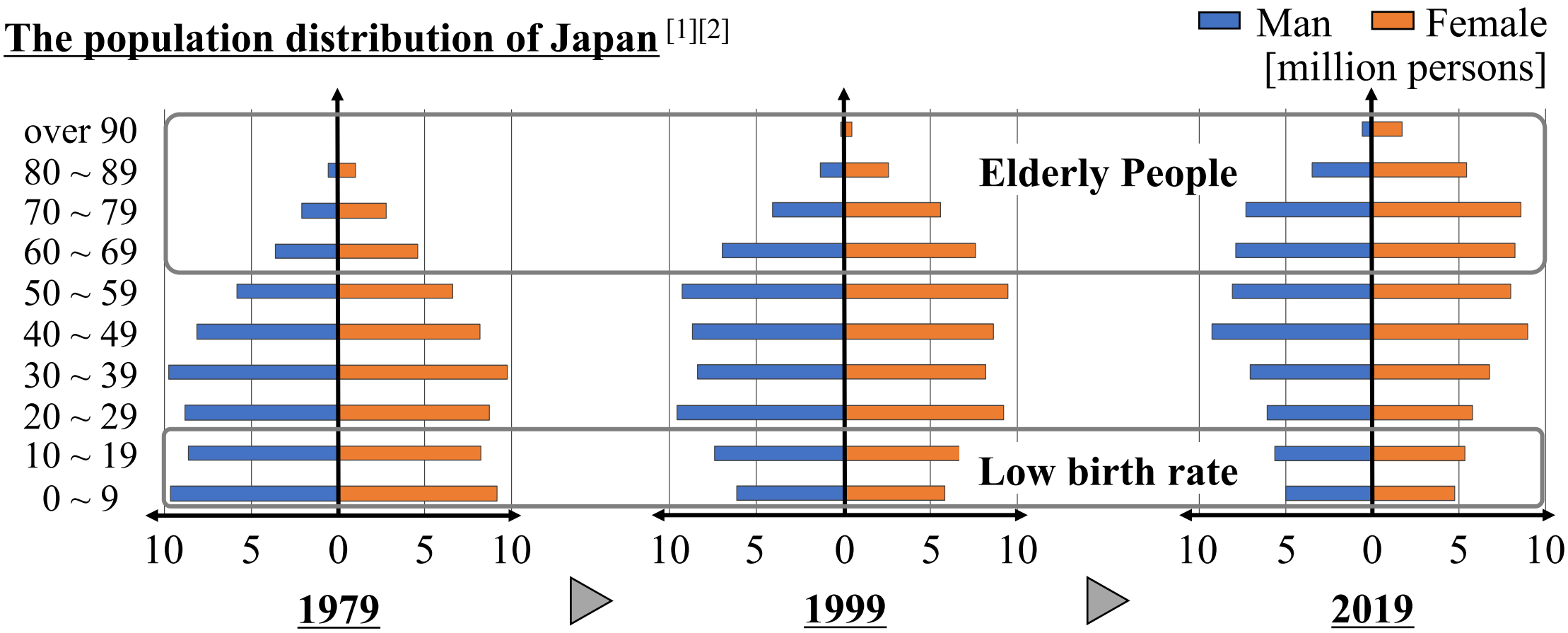
Agenda

- Background
- Research Aim
- The Tools used in This Study
- The Proposed Framework for Drug Picking Activity
- Experiment 1
- Experiment 2
- The Effectiveness of Our Proposed Framework
- Conclusion

■ Background

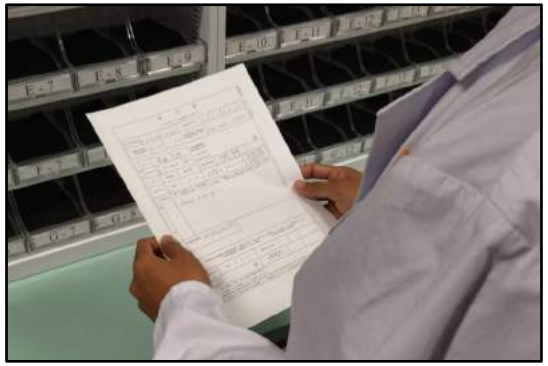
The aging rate is increasing because of medical advancement and decreasing birth rate and so on.

The population distribution of Japan [1][2]



■ Background

Drug picking procedure in Japan


1. Check the prescription


2. Pick the drugs


3. Check the drugs


4. Explain to the patient

A pharmacist's workload is increasing due to expanding the demand of drugs in an aged society. In Japan, non-pharmacists became able to pick some type of drugs in order to decrease the burden on pharmacists. However, picking error tends to occur since some drugs are similar.

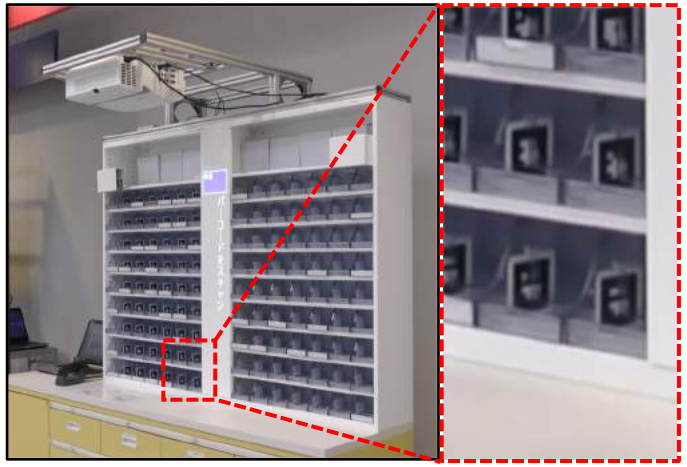
⇨ A system is required to prevent the error during drug picking activity.

■ Background

Previous methods to prevent the error for drug picking activity

1. **Bar-code Scanner** [4]

2. **ADS** [5]



3. **DCM** using AR markers [6]

1. Bar-code or RFID method → Cumbersome to scan

2. Automated Dispensing System (ADS) → Require high cost

3. Dispensing Cabinet Modification (DCM) → Need to install a lot of LEDs or AR markers

Iwate Prefectural University

■ Research Aim

This study attempts to build a framework for judging the drug picking activity in order to detect the errors easily at low-cost.

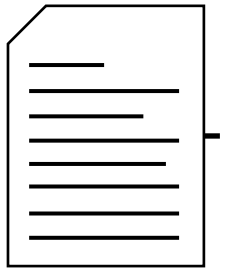
The judgement framework

1. Get drug list

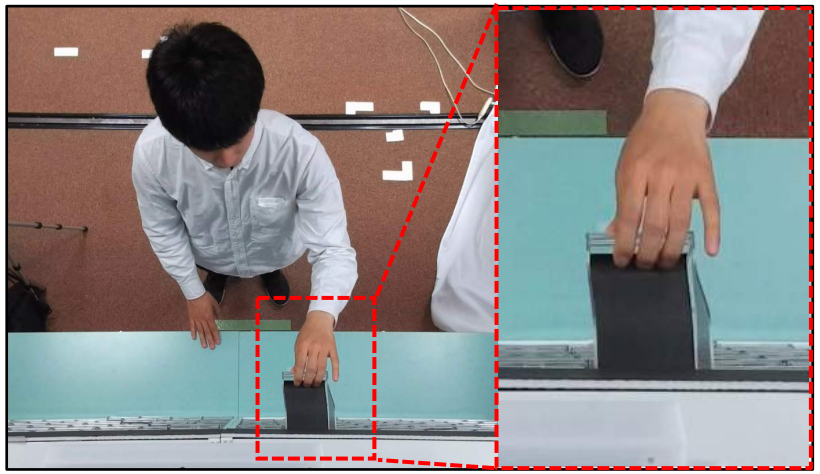
2. Measure the operator's hand movements

3. Judge which drug the operator picks based on the hand

A prescription



Vision Camera



Drug Picking List	Status
- Medicine A 200mg	Acquired
- Medicine B 222mg	Acquired
- Medicine C 190mg	Unacquired
- Medicine D 250mg	Unacquired

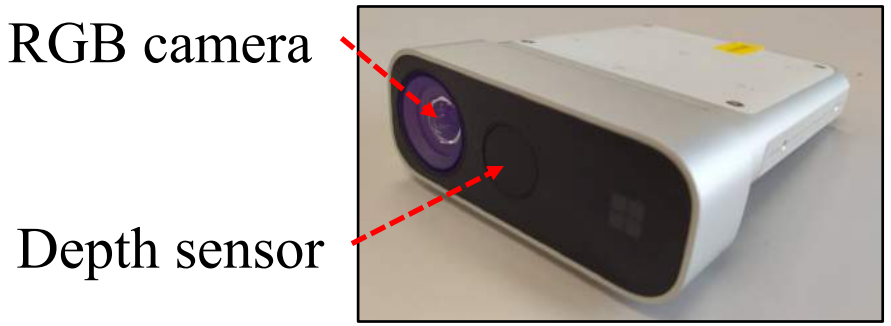
Iwate Prefectural University

■ The Tools used in This Study

Accurate 3D hand detection in real space

➢ **Azure Kinect**

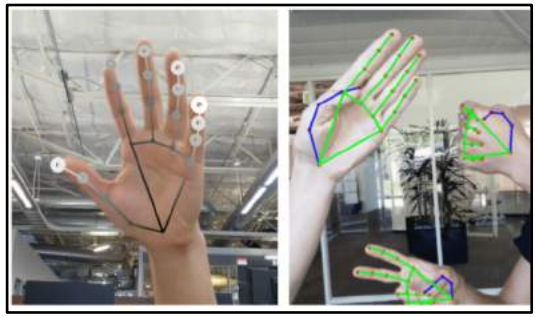
This device can detect the 3D hand landmarks in real space using a depth sensor.



Azure Kinect [7]

➢ **MediaPipe library**

This software library can detect the 2D hand landmark from an RGB image using Convolutional Neural Network.

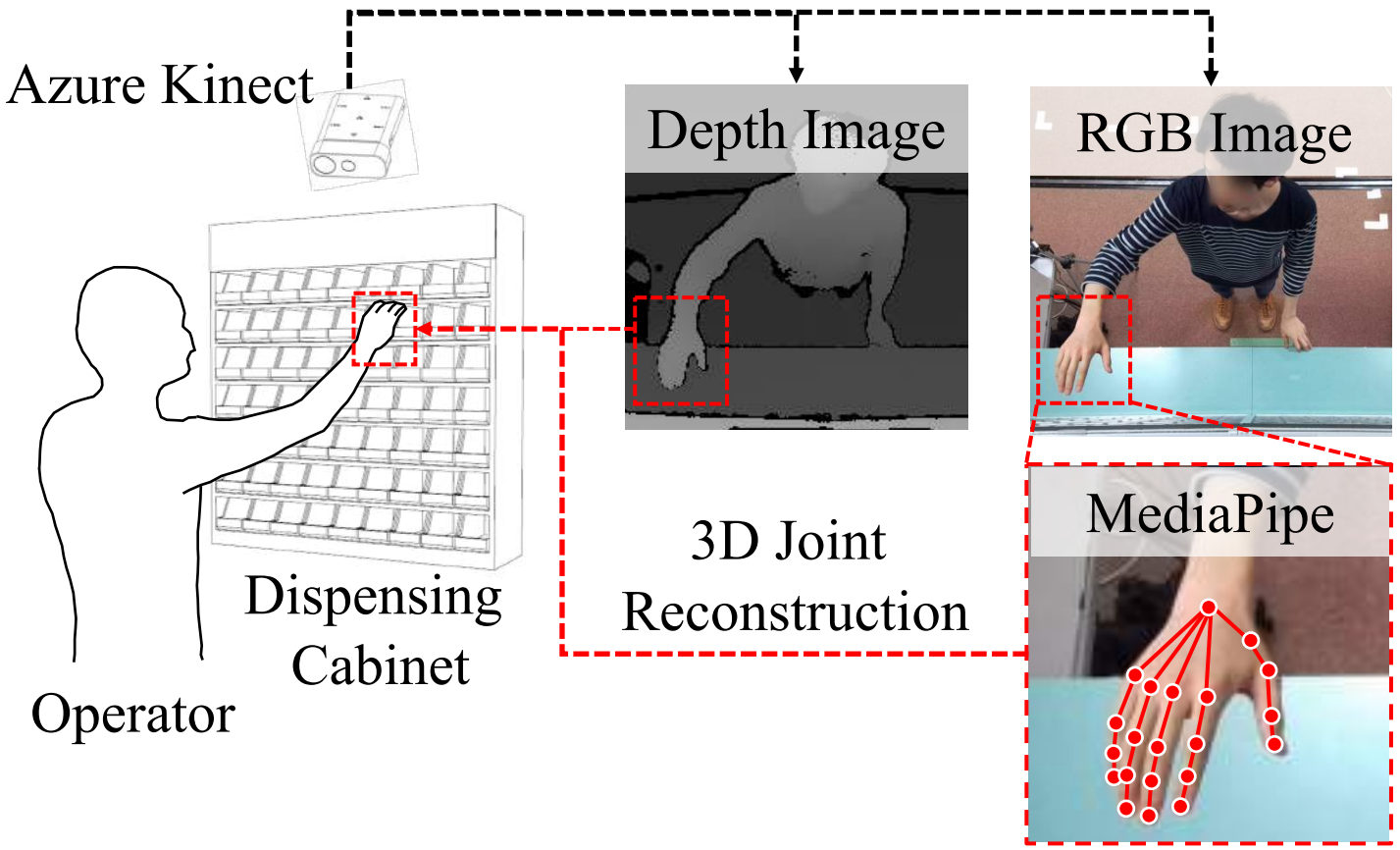


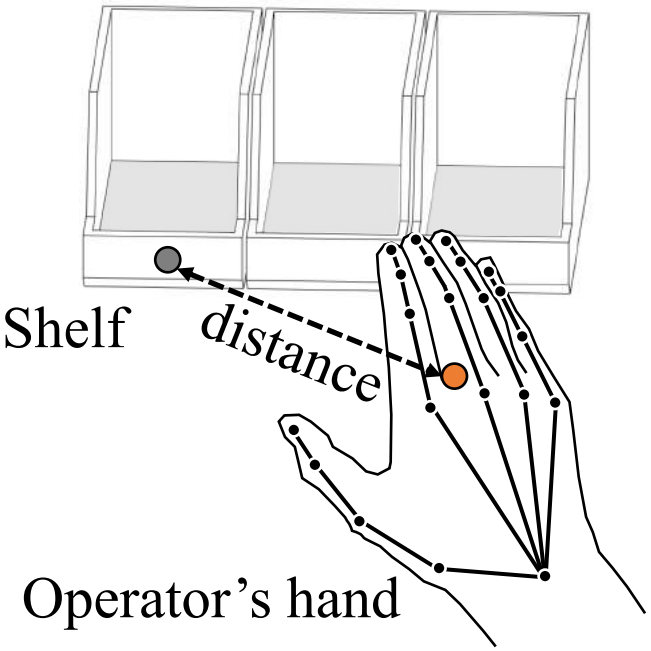
MediaPipe library [8]

We expect that 3D hand landmarks can be detected accurately by combining the Azure Kinect with the MediaPipe library.

■ The Proposed Framework for Drug Picking Activity

Our framework judges which shelf the operator has pulled based on the position of the hand and the position of the shelf.



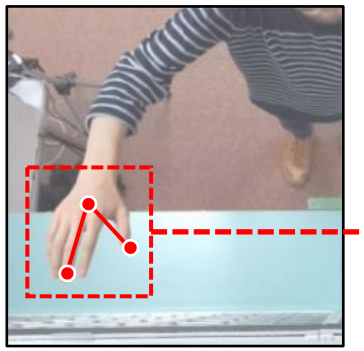


- Shelf reference position
- 3D center position of hand landmarks

■ The Proposed Framework for Drug Picking Activity

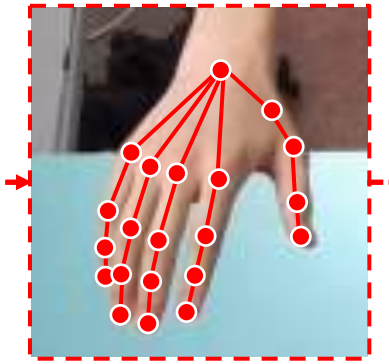
The hand detection procedure

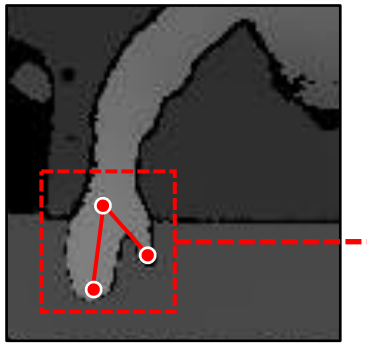
1. The Azure Kinect detects the hand landmarks ▶ 2. The MediaPipe library detects the 2D hand landmarks ▶ 3. Generate the 3D hand landmarks



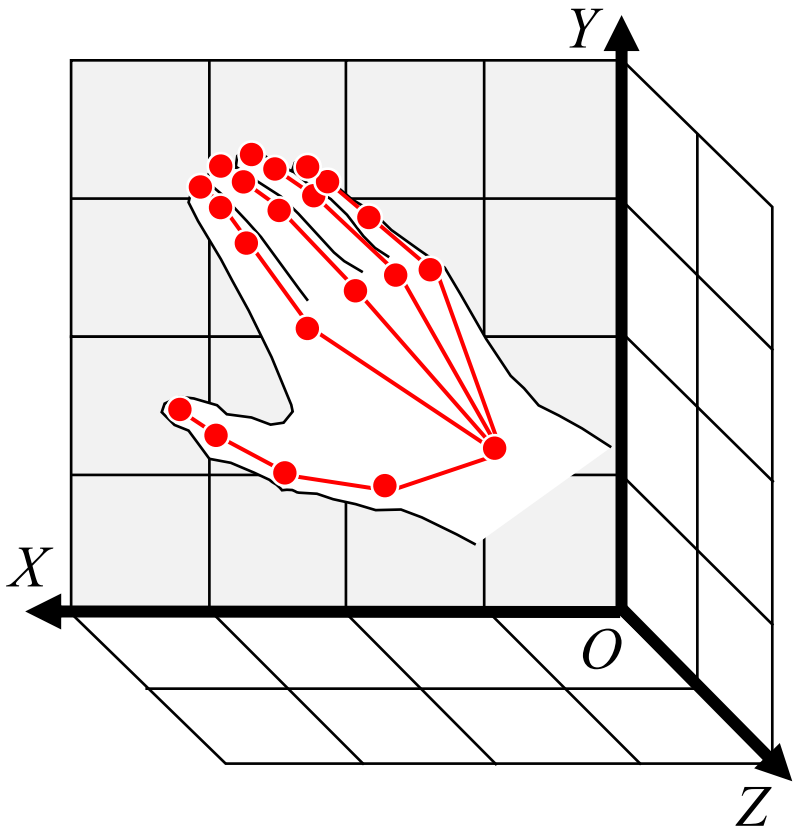
RGB Image

Extract the ROI





Depth Image



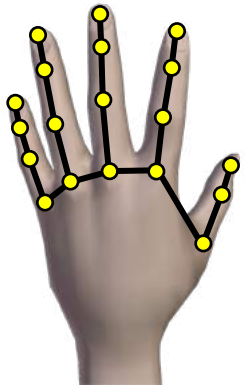
■ The Proposed Framework for Drug Picking Activity

The judgement procedure

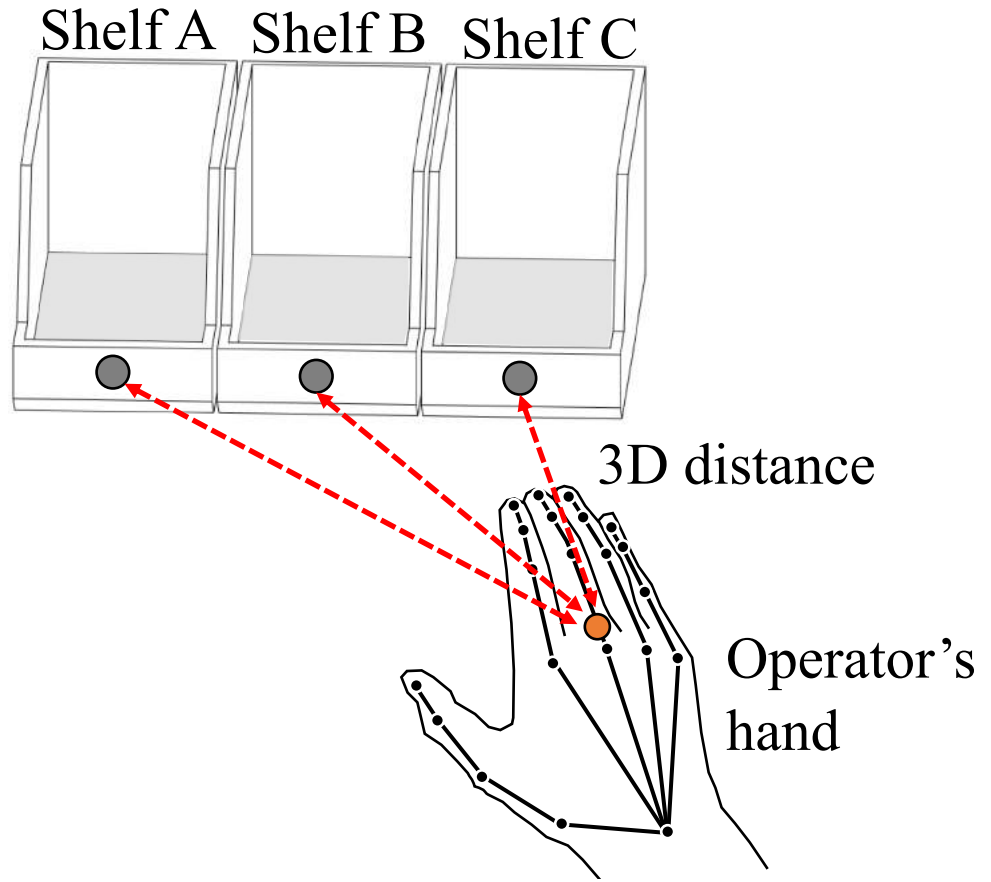
1. Calculate the 3D center position of the operator's hand
2. Identify the nearest reference shelf from the hand
3. Judge the shelf as "operated shelf"
   if it is detected as nearest for more than 0.5 seconds

How to calculate the 3D center position of the hand?

The finger landmarks are used to calculate
the 3D center position of the hand.



Yellow circles indicate
the finger landmarks in
the MediaPipe library

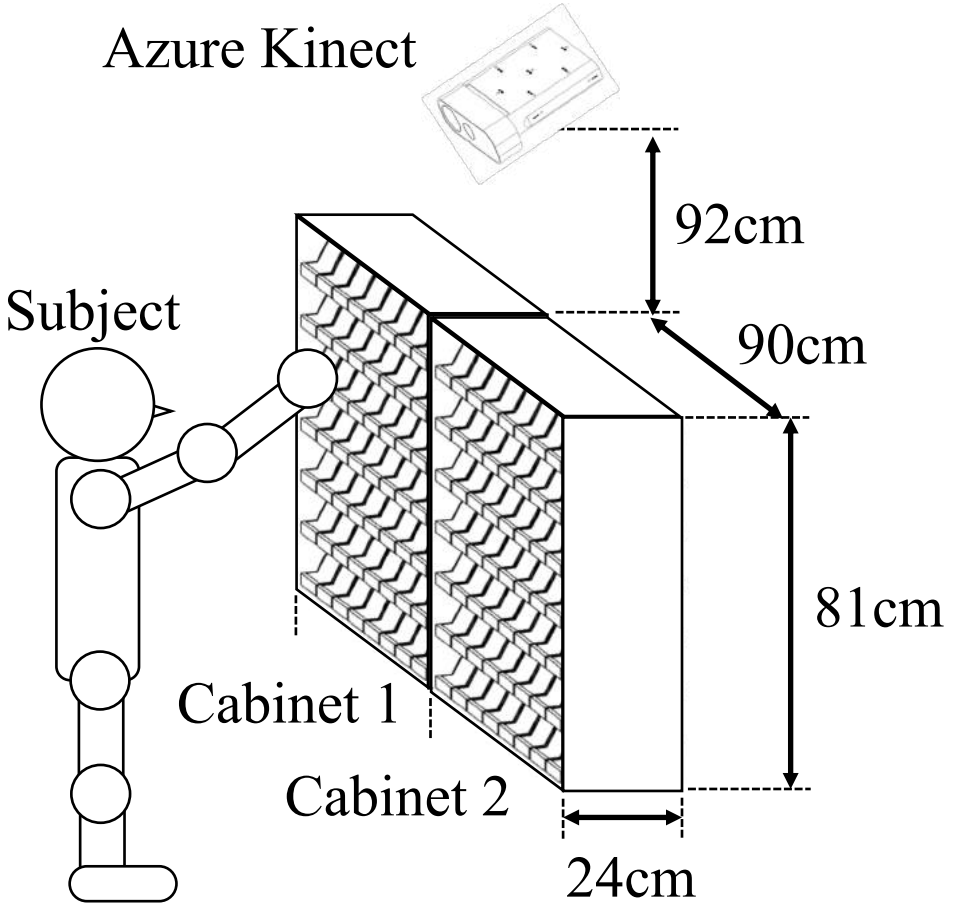


- Reference shelf position
- 3D center position of hand landmarks
- 3D distance between the shelf and the center position of the hand

■ Experiment 1

The experiment environment

- **Subject**: 5 persons
- **Dispensing cabinet**
  - Capacity: 63 shelves (7rows × 9columns)
  - A shelf size: 9.4cm × 10.6cm × 13.3cm
  - Align two cabinets side by side
  - Put cabinets at a height of 85.5cm above floor
- **Azure Kinect**
  - RGB camera: 1920 × 1080px, 90° × 59°
  - Depth sensor: 512 × 512px, 120° × 120°

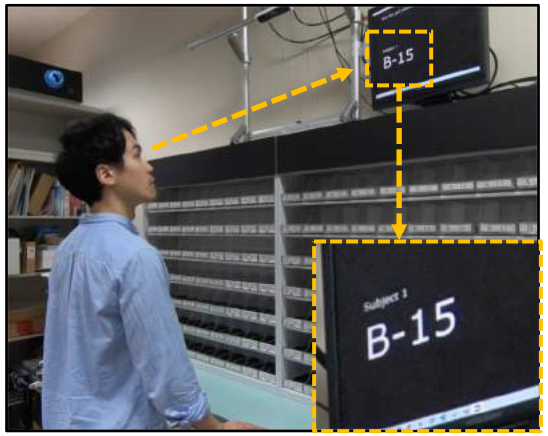


■ Experiment 1

The experiment procedure

1. Stand initial position

2. Show a shelf ID by the monitor



Each shelf has the ID

3. Pull the shelf

4. Return back initial position

5. Repeat these steps above until the subject operates each shelf only once

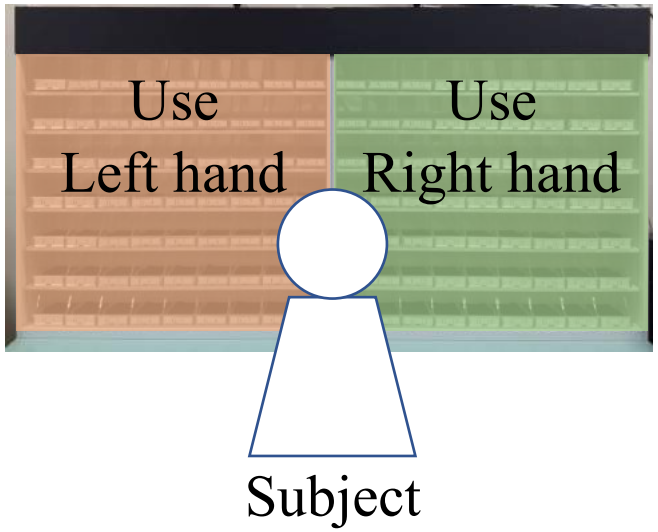
Iwate Prefectural University

■ Experiment 1

<u>The constraints during our experiments</u>

We impose the constraints on the subject's movement in order to avoid uneven operation depending on the subject's behavior at that time.

• To use specific hand side



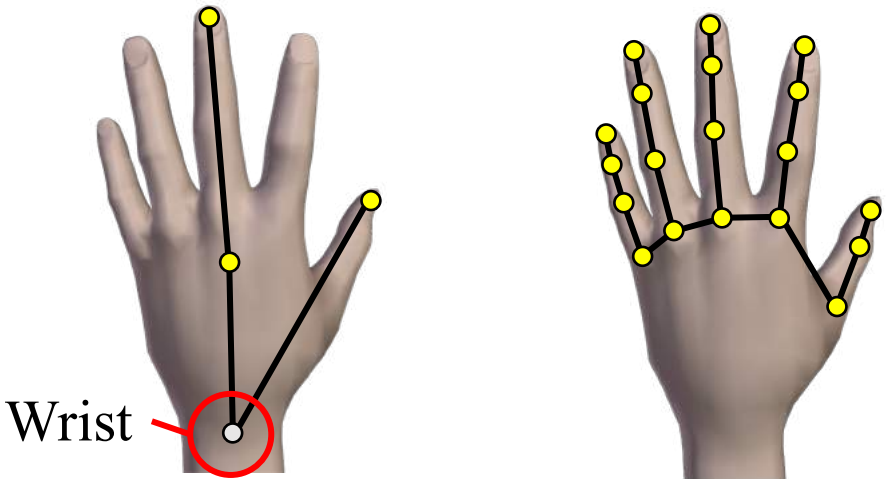
• The back of the hand faces upward

Iwate Prefectural University

■ Experiment 1

Comparison in different hand landmarks

- The wrist position of Azure Kinect
- Hand_{ak}: The center of hand landmarks of the Azure Kinect without the wrist
- Hand_{mp}: The center of hand landmarks of the MediaPipe library



Azure Kinect　　MediaPipe library

Result

The hand landmarks of the MediaPipe library can judge more accurately.

	Azure Kinect		MediaPipe library
Subject	Wrist	Hand_{ak}	Hand_{mp}
A	43%	99%	100%
B	18%	89%	99%
C	32%	90%	99%
D	63%	93%	98%
E	30%	79%	99%
All	37%	90%	99%

Iwate Prefectural University

■ Experiment 2

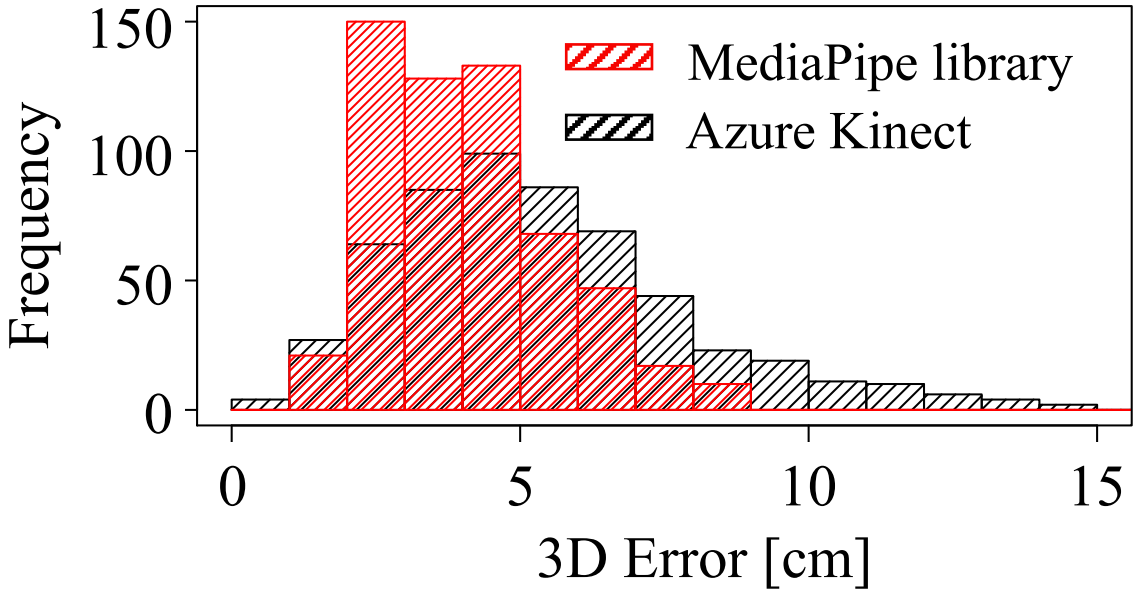
The experiment procedure

1. Extract the hand position manually by the tester when the subject grasps the target shelf
2. Calculate the 3D Euclidean distance between the hand and the shelf
3. Compare the difference between the distance for each landmarks using Welch's test

Landmark	Mean	SD
Azure Kinect	5.4 cm	2.5 cm
MediaPipe library	4.1 cm	1.5 cm

Result

The MediaPipe library is better than the Azure Kinect for the judgement.



Iwate Prefectural University

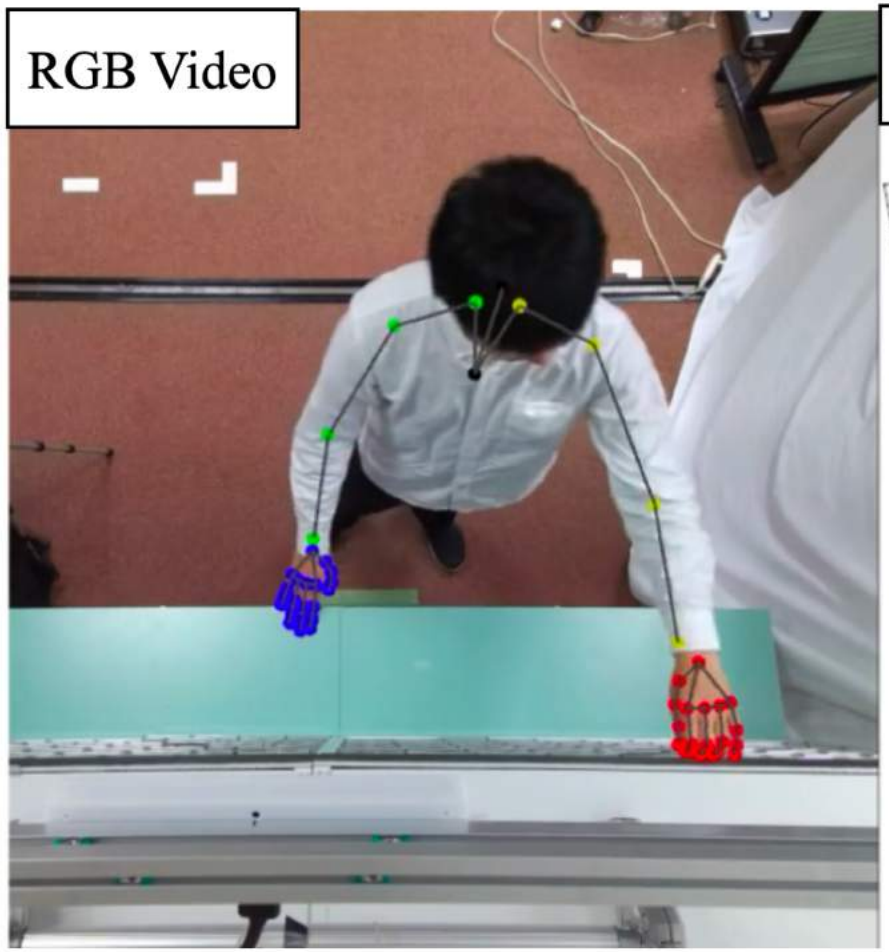
■ The Effectiveness of Our Proposed Framework

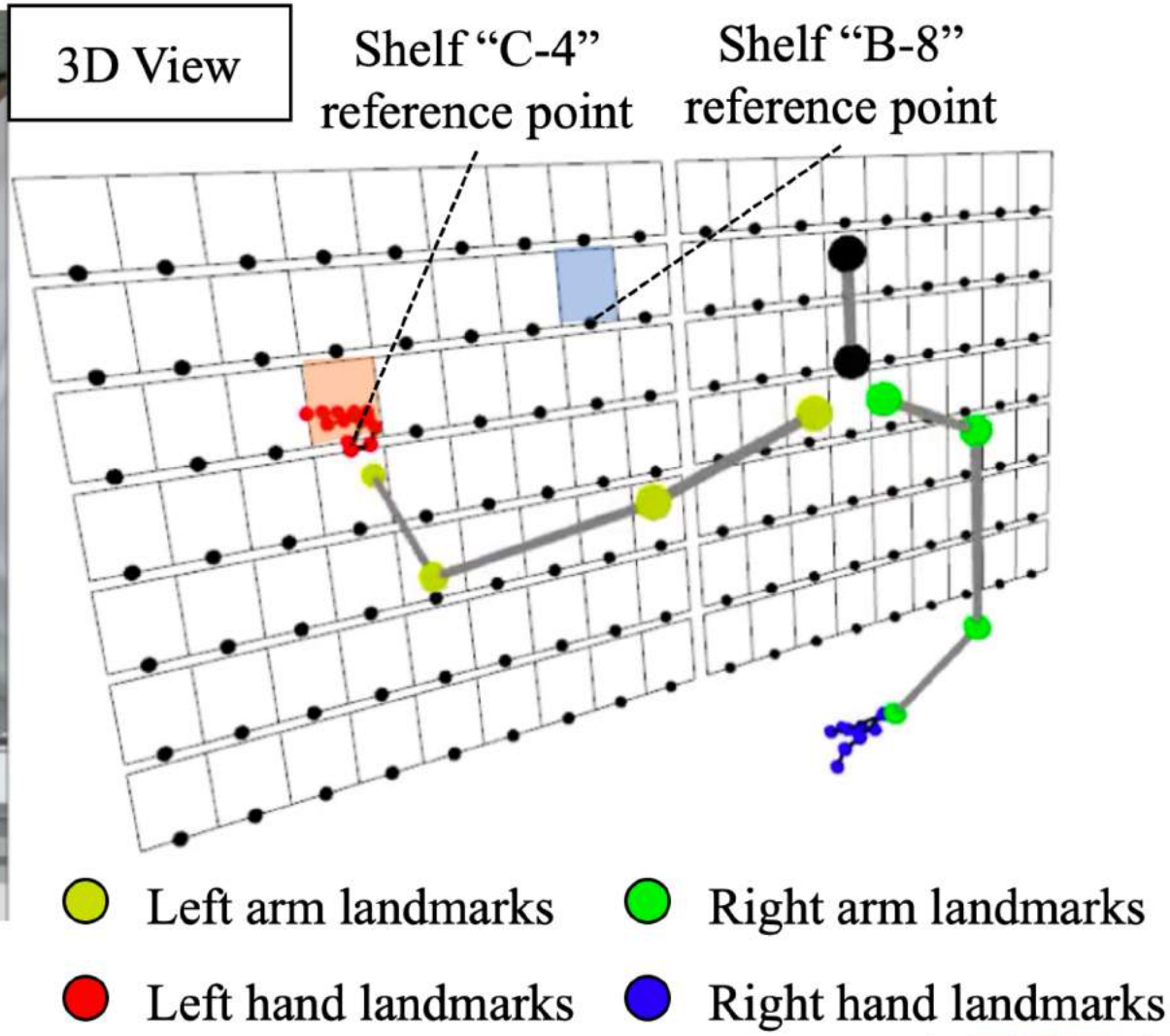
Ground Truth

C-4

Judgement

C-4





■ Conclusion

Achievement

- Accurate measuring 3D location of operator's hand using the Azure Kinect and the MediaPipe library
- Reliable judgement procedure for the drug picking activity
- Easy-used and low-cost the judgement framework for drug picking activity

Future work

- Verify the judgement accuracy for the activity without the constraints of the operator's movement

Iwate Prefectural University

References

[1] e-Stat, Statistics of Japan, https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00200524&tstat=000000090001&cycle=0&tclass1=000000090004&tclass2=000000090005&tclass3val=0

[2] Population Division World Population Prospects 2019, https://population.un.org/wpp/

[3] Statistics Bureau of Japan, Current Population Estimates as of October 1, 2019, https://www.stat.go.jp/data/jinsui/2019np/index.html (in Japanese)

[4] ZEBRA Technologies Corp., DS8100-HC SERIES 1D/2D HANDHELD IMAGERS, https://www.zebra.com/us/en/products/scanners/healthcare-scanners/ds8100-hc.html

[5] YUYAMA MANUFACTURING CO., LTD., https://www.yuyama.co.jp/product/products/web_catalog/DrugStation/html5.html#page=3

[6] AOIO SYSTEMS CO., LTD., Projection Picking System (PPS), https://www.hello-aioi.com/en/solution/digital_picking/projection/pps/

[7] Microsoft Azure, “Azure Kinect DK,” https://azure.microsoft.com/en-us/services/kinect-dk/

[8] F. Zhang et al., “MediaPipe hands: on-device real-time hand tracking,” pp. 1-5, Jun. 2020, arXiv:2006.10214

[9] Pharmaceutical Safety and Environmental Health Bureau, “The state of dispensing operations”, https://www.mhlw.go.jp/content/000498352.pdf (in Japanese)