



## Automated Bin Picking with 3D Machine Vision ARE15

## Organizer

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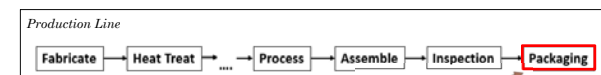
## Outline

- ① **INTRODUCTION**
  - Background and problem Statement
  - Objective and scope
  - Literature Review
- ② **BIN PICKING SYSTEM**
  - Overview System
- ③ **Experiment**
  - Robot Pick and Place
- ④ **Conclusion**
  - Problems
  - Future work



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## INTRODUCTION → Background and problem Statement

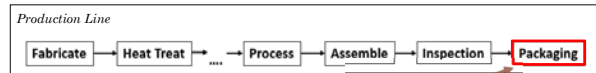


Problems

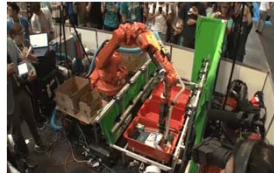


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# INTRODUCTION → Background and problem Statement



Solution



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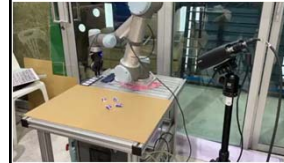
# INTRODUCTION → Background and problem Statement → Objective and scope

## Objectives

- Detect the pose of the targeted object randomly placed/plied using the 3D camera.
- Control the robot arm based on pose identification.
- Pick and place the targeted object in the workspace of robot.

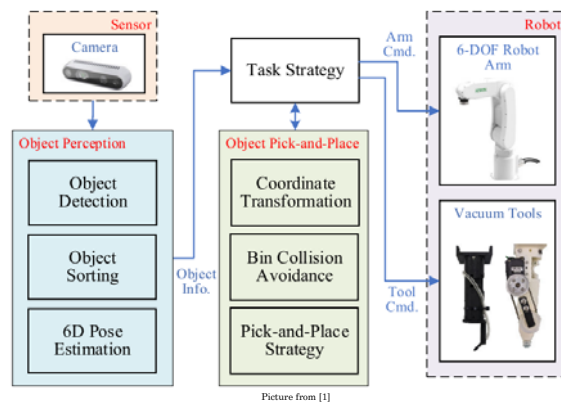
## Scope of study

- Select the duplicate object in the workspace, The object must be not transparent and scattered object.
- Pick the object in the workspace and then place and arrange to the other place with depth camera to find the position and orientation.
- Create 3D Model by 3D camera.



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# INTRODUCTION → Literature review



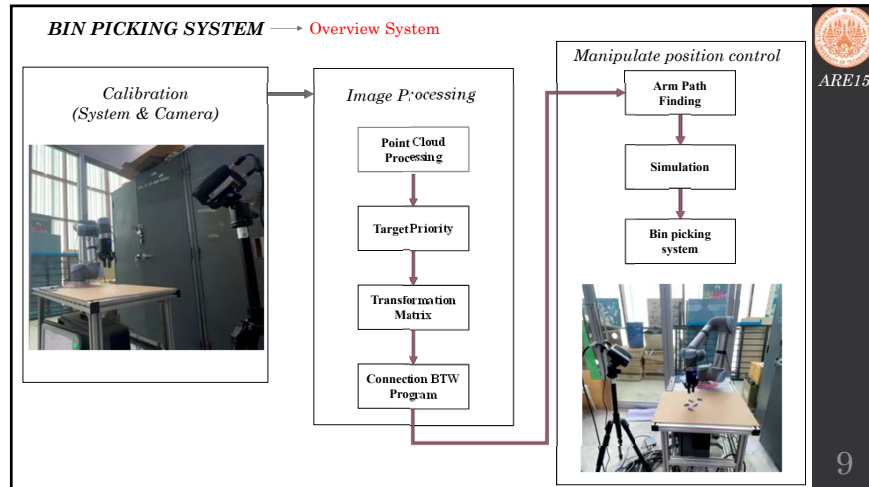
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**Calibration (System & Camera)**

**ZIVID TWO**

Typical specifications

Typical numbers are given at common conditions unless otherwise specified.

Property	Description	Typical
Warm-up time	Minimum recommended time needed for camera to stabilize from an idle state assuming capturing at a constant rate. Some trueness changes may be experienced during warm-up phase.	10 minutes
Point precision	1 $\sigma$ Euclidian distance variation for a point between consecutive measurements at focus distance, D. $\mu$	55 $\mu$ m
Local Planarity Precision	1 $\sigma$ Euclidian distance variation from a plane for a set of points within a smaller local region at focus distance, D. $\mu$	75 $\mu$ m
Global Planarity Trueness	Average deviation from a plane in field of view at focus distance, D.	< 160 $\mu$ m
Dimension Trueness	70-percentile dimension error in field of view at focus distance, D, and typical temperature range.	< 0.20 %
	70-percentile dimension error in field of view within optimal working distance and typical temperature range.	< 0.30 %
	70-percentile dimension error in field of view within optimal working distance and full temperature range.	< 0.40 %

Picture from [8]

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**Calibration (System & Camera)**

**Calibrate the Camera**

ZIVID TWO

To get the picture that most accuracy to the real world

$$K = \begin{pmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{pmatrix}$$

- Camera Matrix

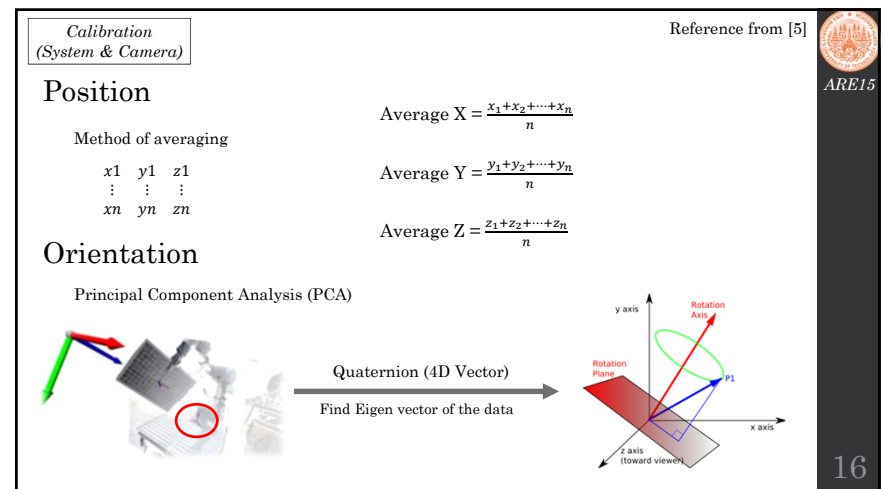
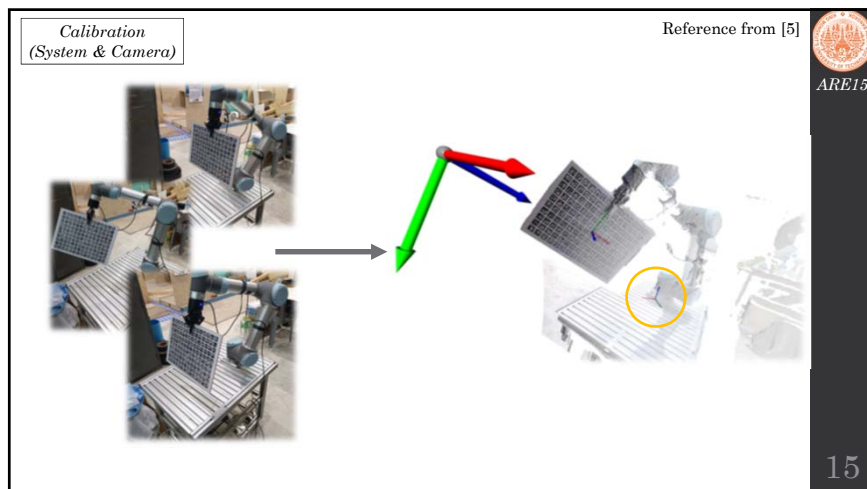
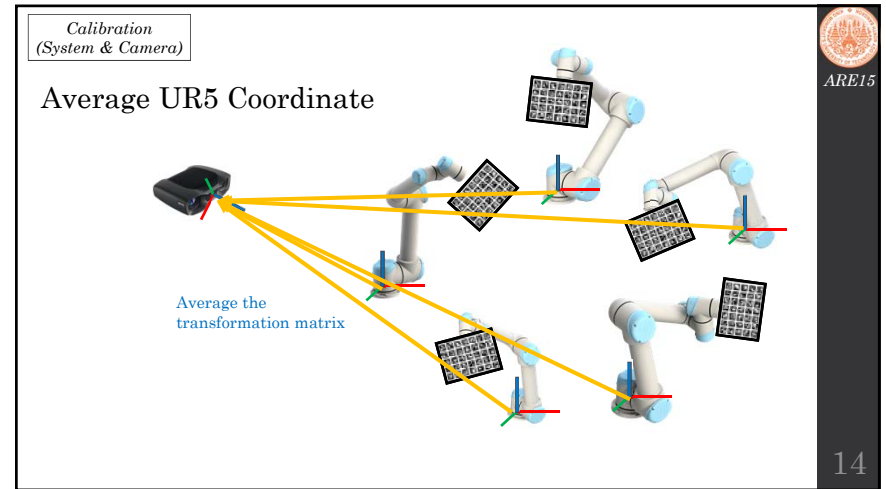
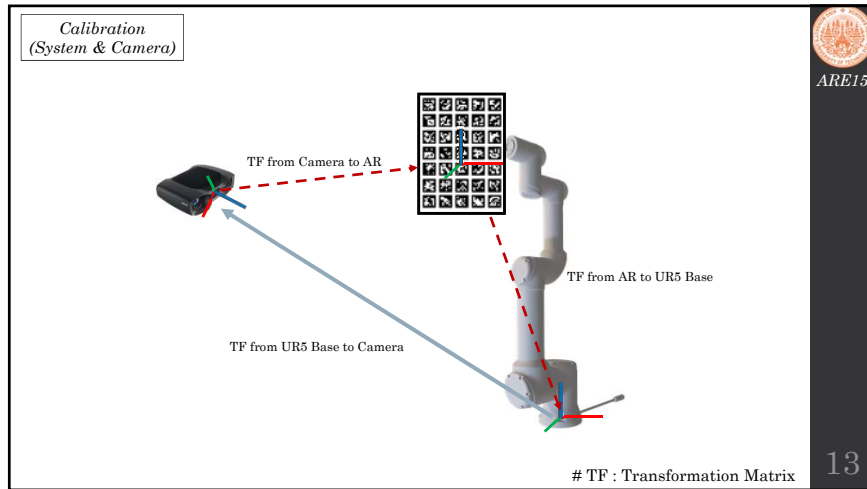
- Camera Distortion

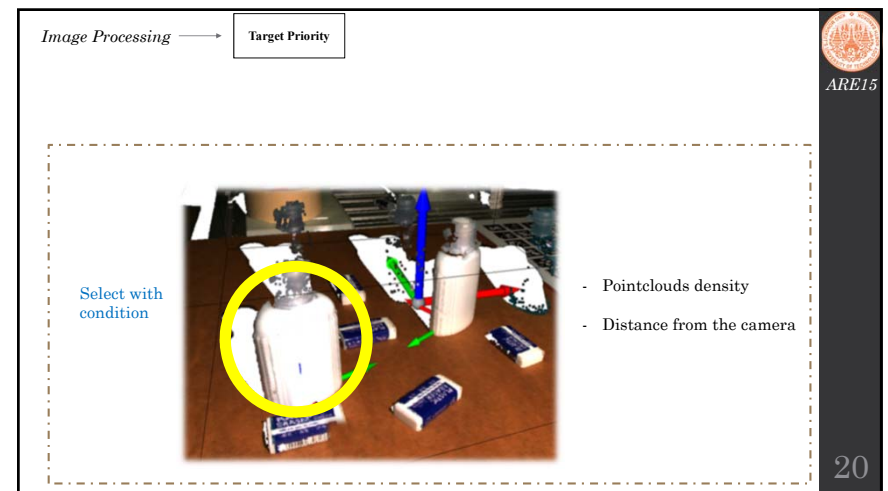
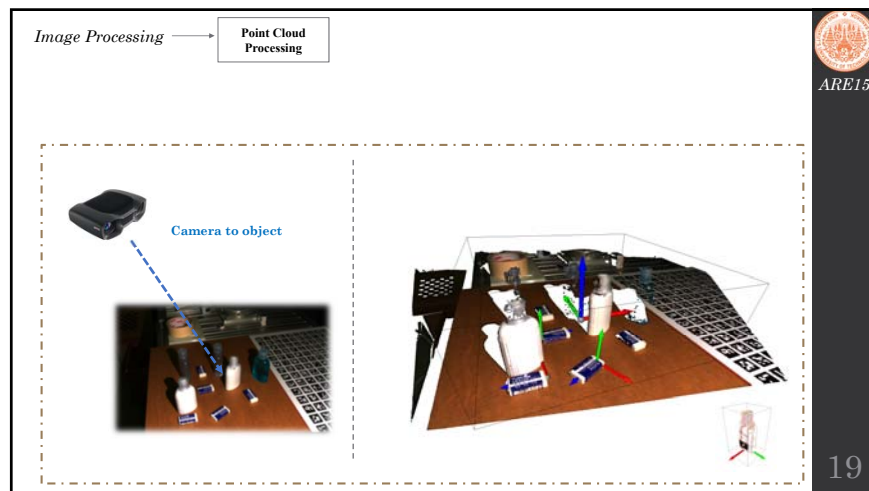
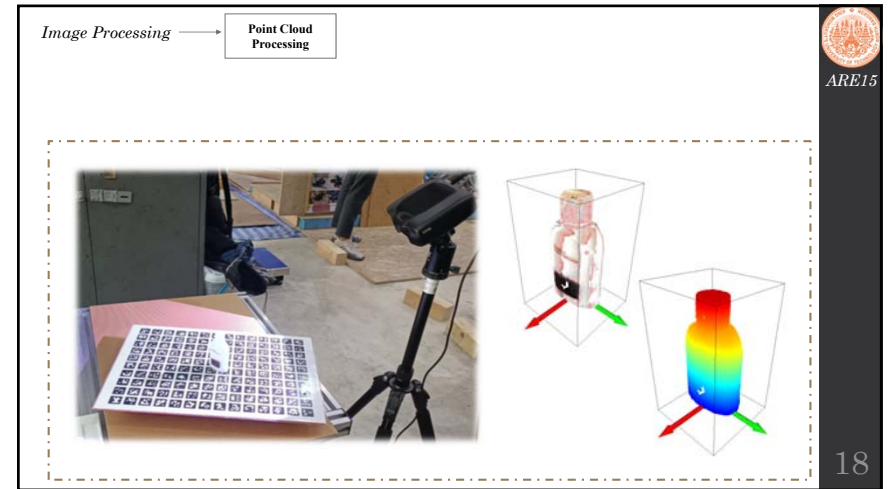
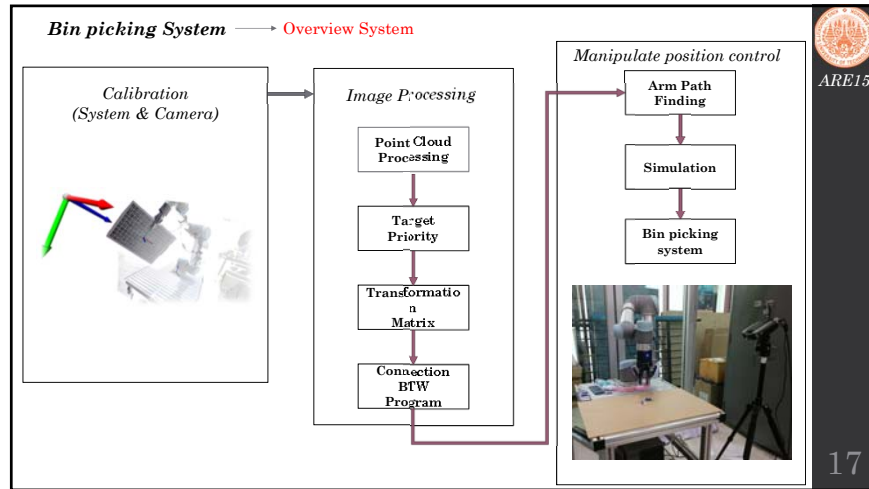
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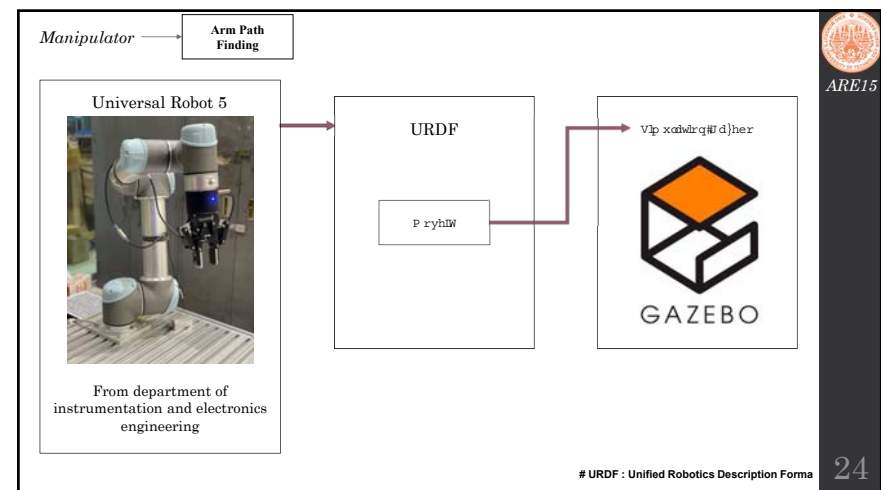
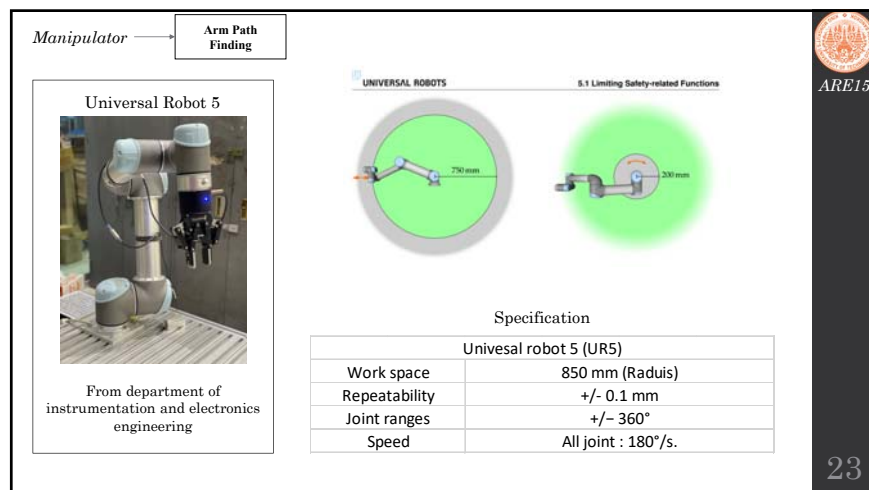
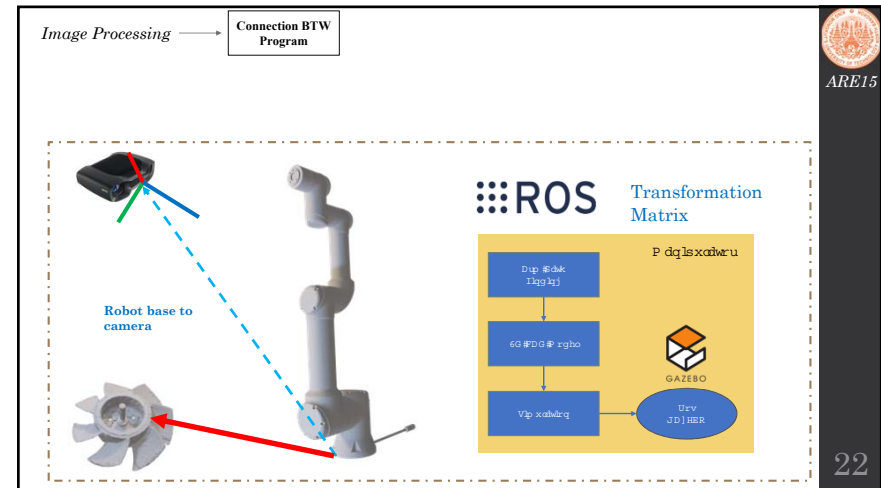
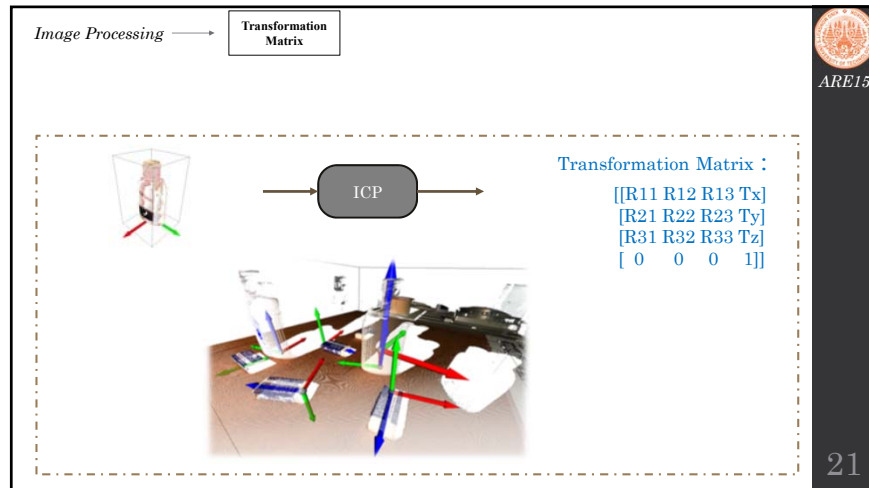
**Calibration (System & Camera)**

**Calibrate the System**

To find connection between camera and robotic arm

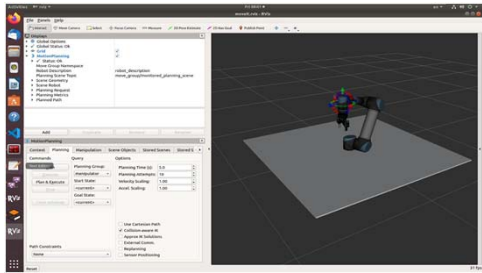








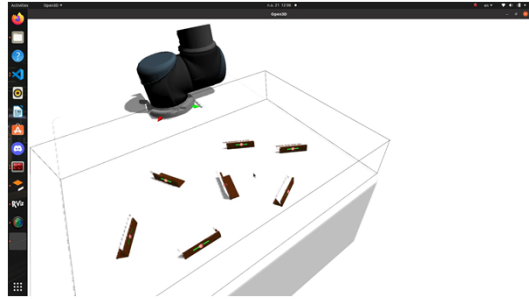
Manipulator → Arm Path Finding → MoveIT



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Manipulator → MoveIT → `vlp_xairq#jd}her`



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**Bin picking System** → Overview System



Calibration (System & Camera)

Image Processing



- Point Cloud Processing
- Target Priority
- Transformation Matrix
- Connection BTW Program

ICP

ROS

Manipulate position control

- Arm Path Finding
- Simulation Gazebo
- Bin picking system

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**Experiment** → **Bin picking system**

**Robot Gripper**

2F-85

One of the object side must not larger than 85mm so the gripper can pick.

**Pick workspace**

The object need to be in the workspace of 30cm\*30cm\*10cm

30cm x 30cm x 10cm

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**Experiment** → **Bin picking system**

**3 Phase of Experiment**

Sample Object → Camera Calibrate → Camera Position

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**Experiment** → **Bin picking system**

Sample Object → Camera Calibrate → Camera Position

Aluminium angle

Eraser

Reduce Light reflection properties

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**Experiment** → **Bin picking system**

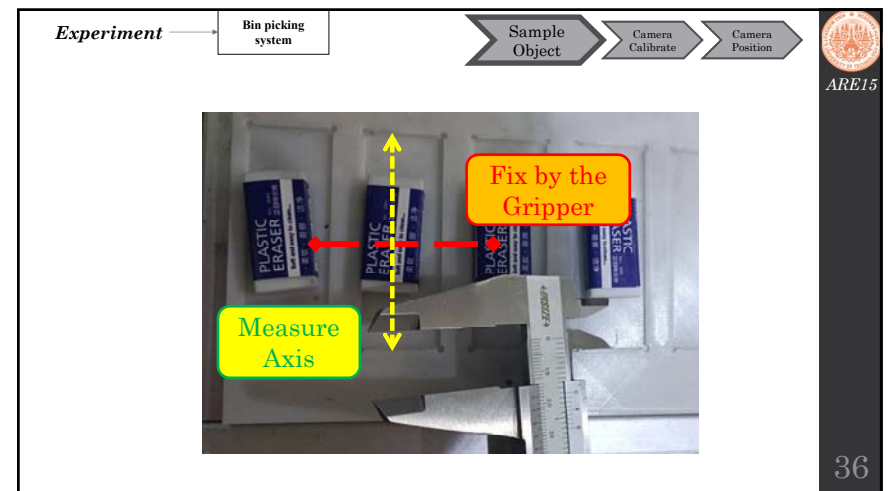
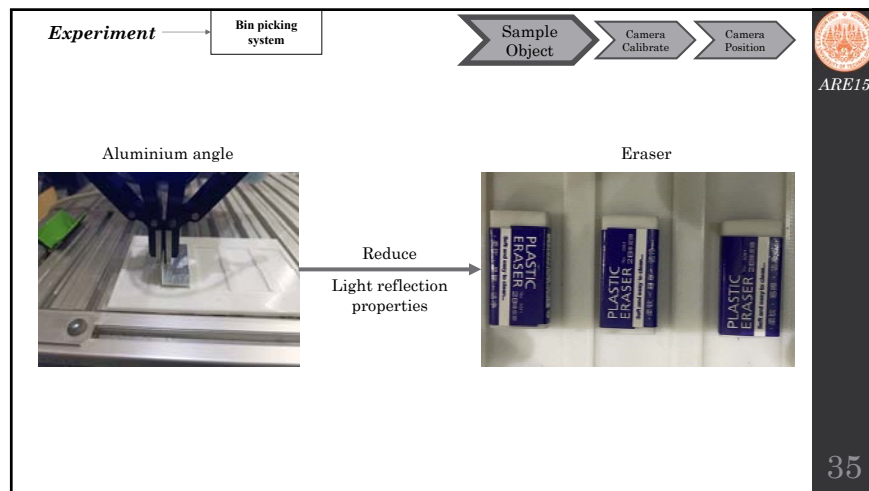
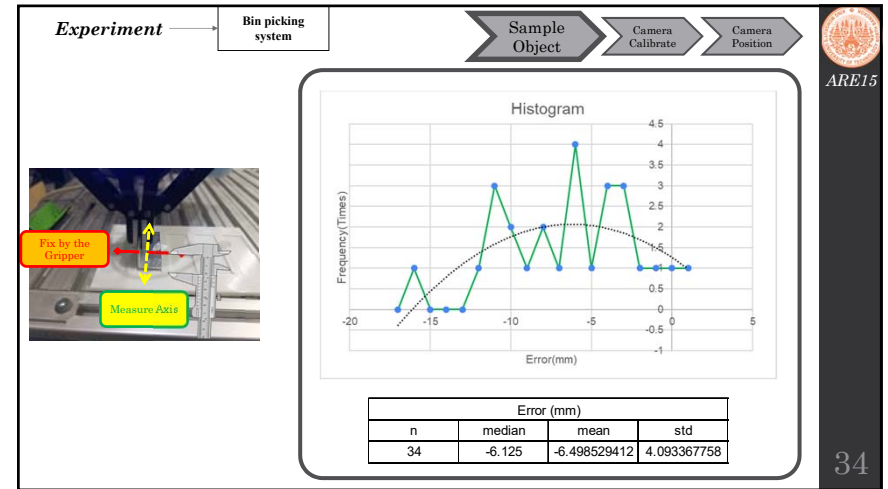
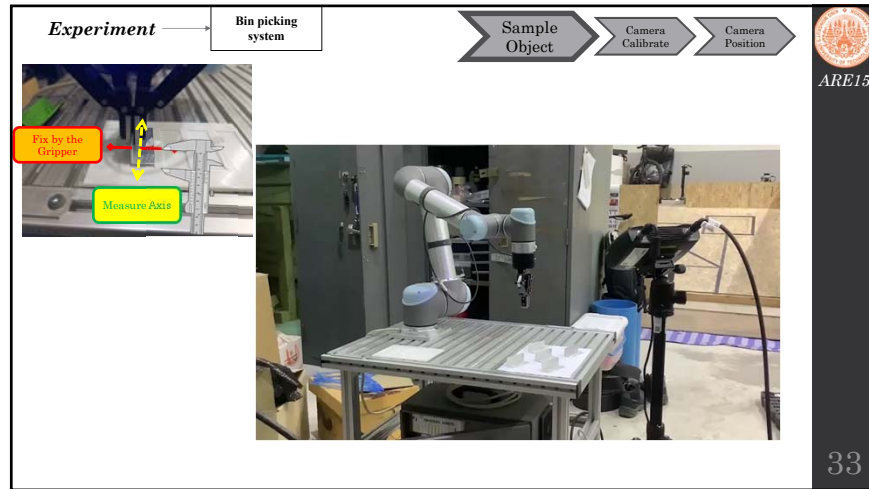
Sample Object → Camera Calibrate → Camera Position

Fix by the Gripper

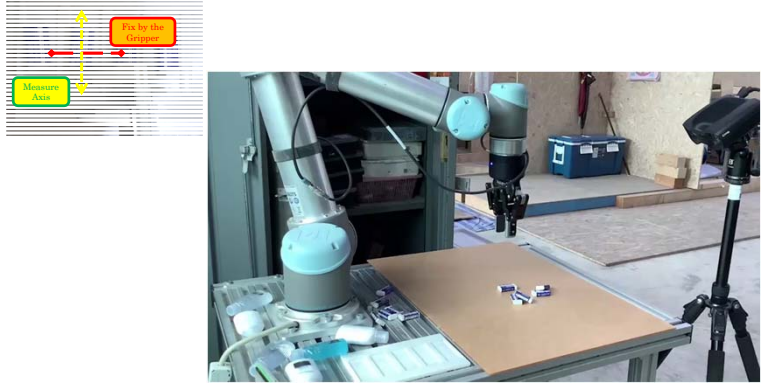
Measure Axis

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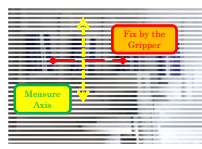
**Experiment** → Bin picking system → Sample Object → Camera Calibrate → Camera Position



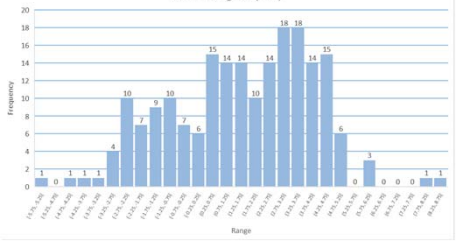
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**Experiment** → Bin picking system → Sample Object → Camera Calibrate → Camera Position



**Error Histogram (mm)**


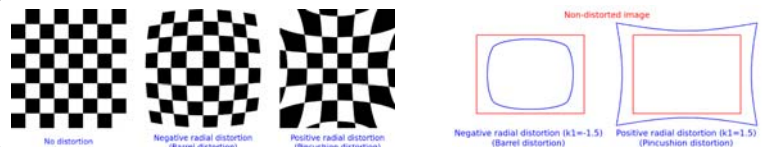


Error (mm)			
n	median	mean	std
200	1.775	1.533	2.505142

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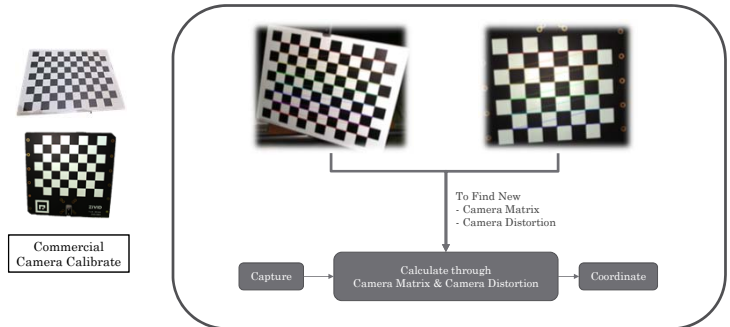
**Experiment** → Bin picking system → Sample Object → Camera Calibrate → Camera Position

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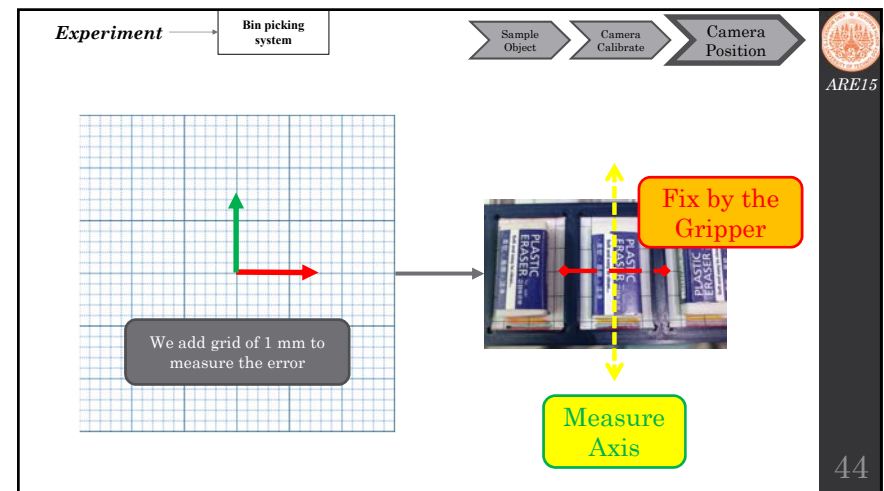
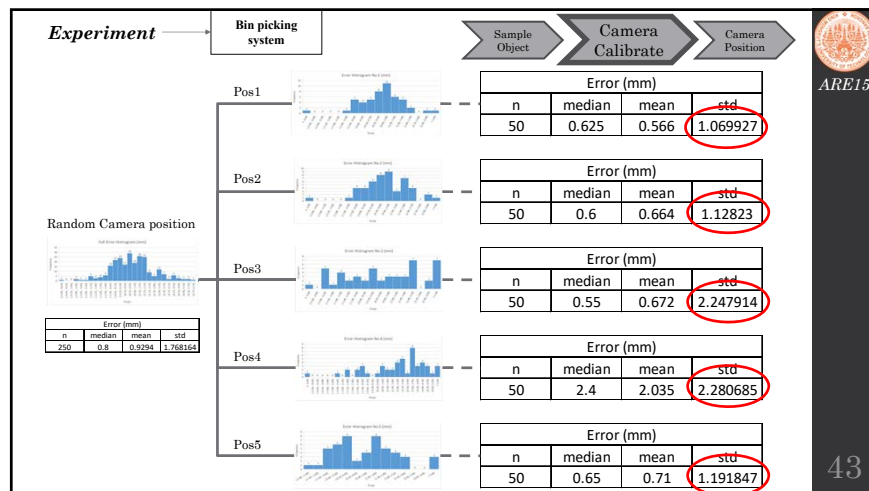
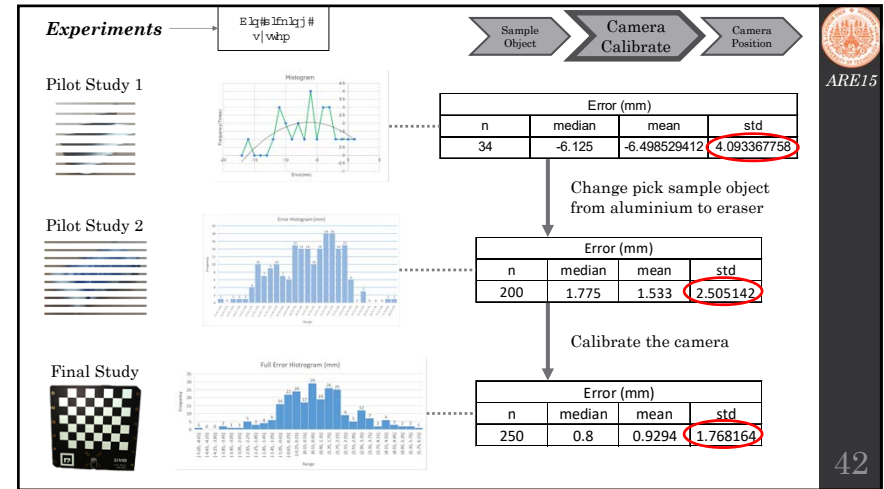
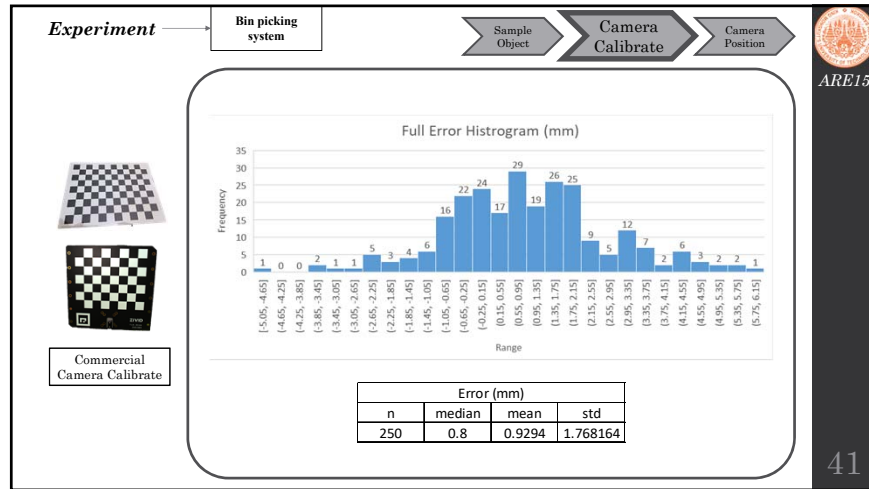
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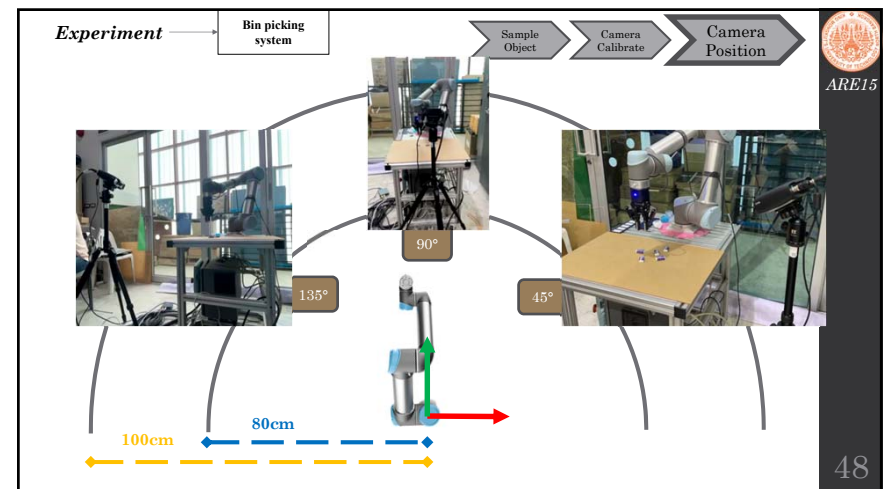
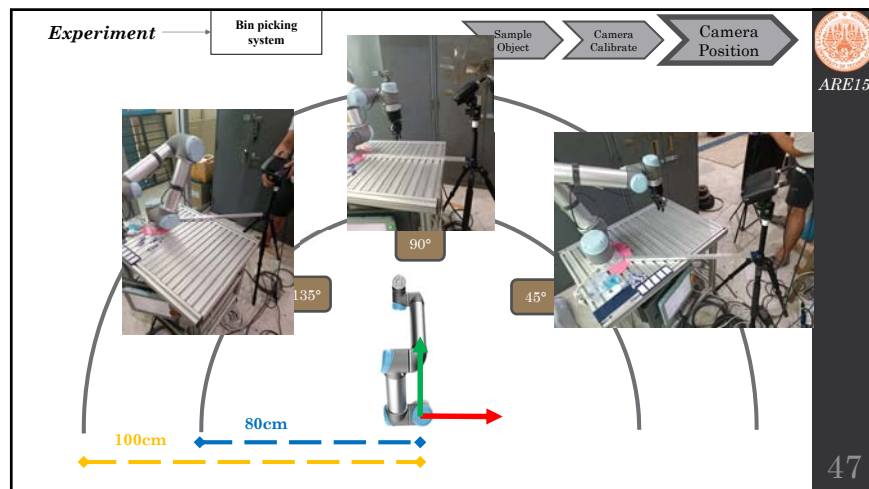
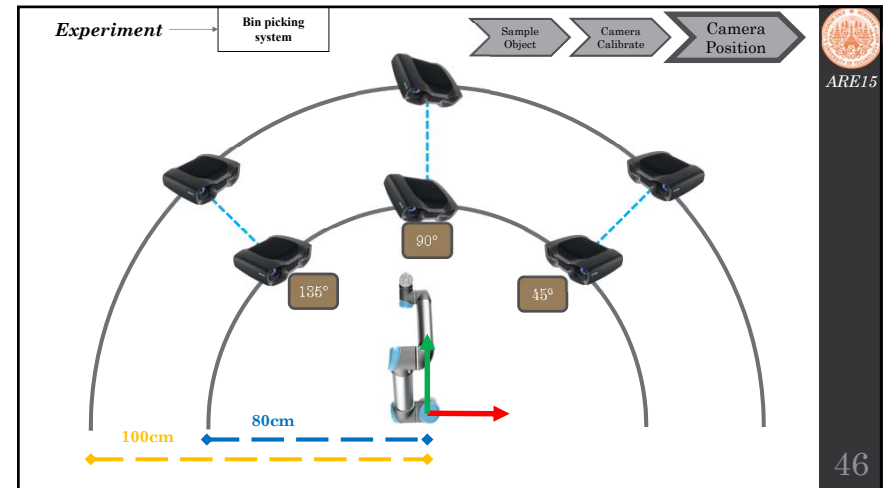
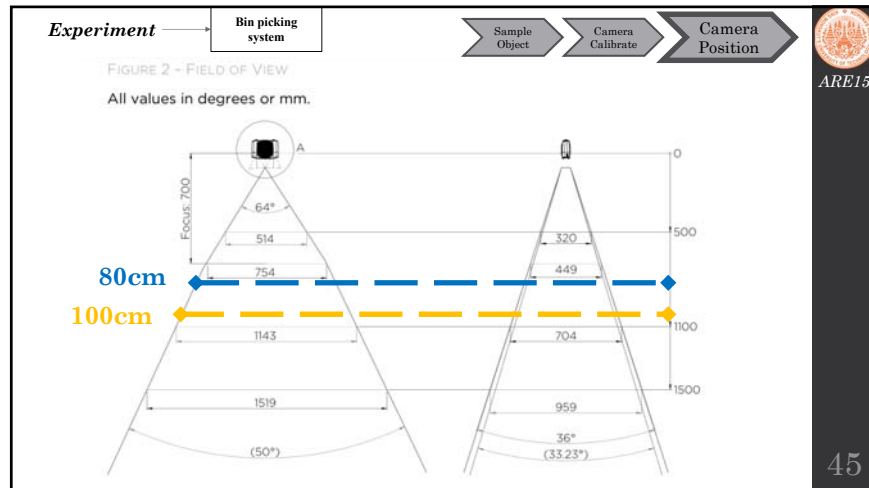
**Experiment** → Bin picking system → Sample Object → Camera Calibrate → Camera Position

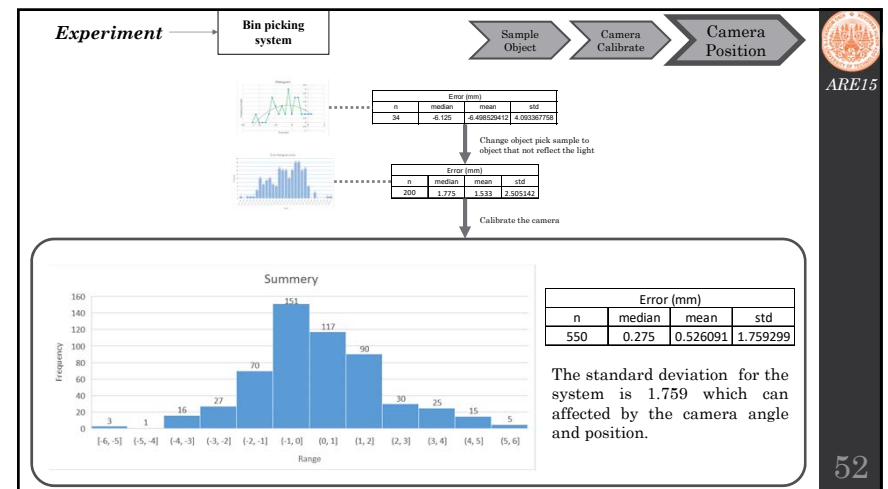
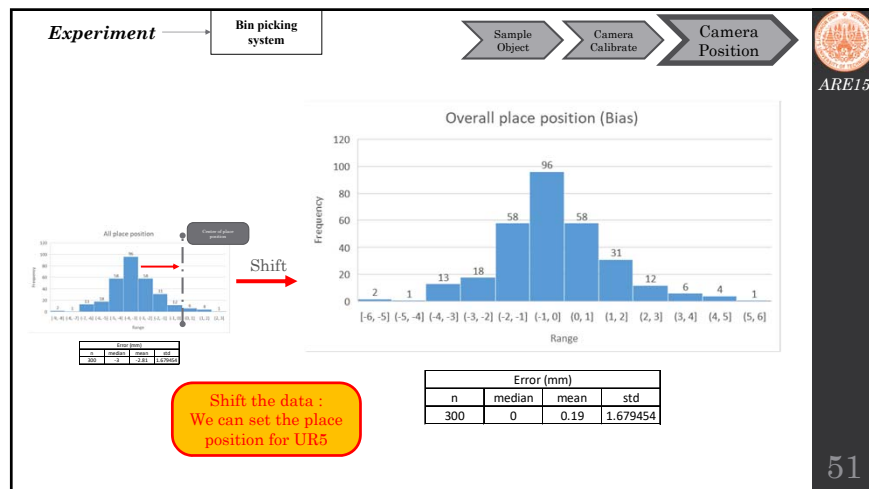
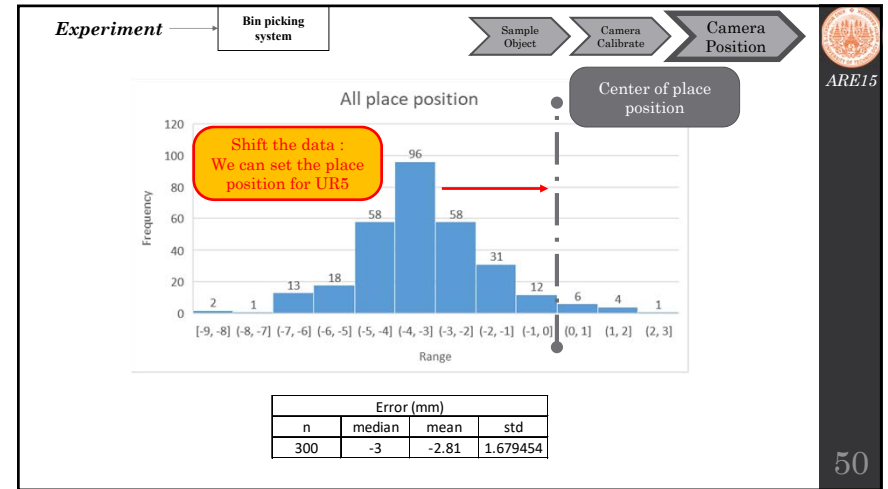


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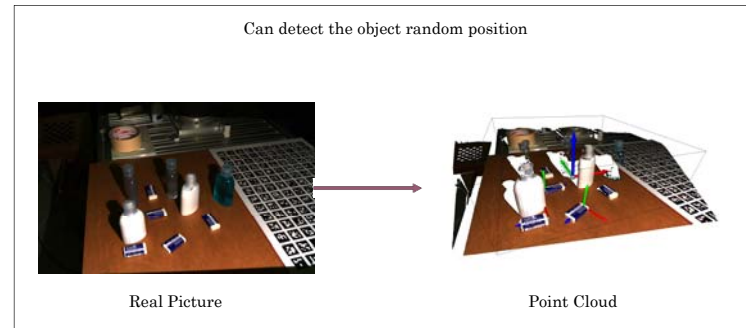


## Outline



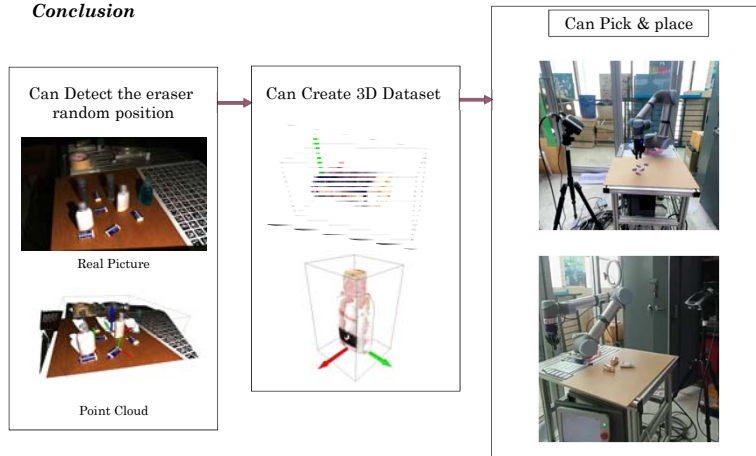
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## Conclusion



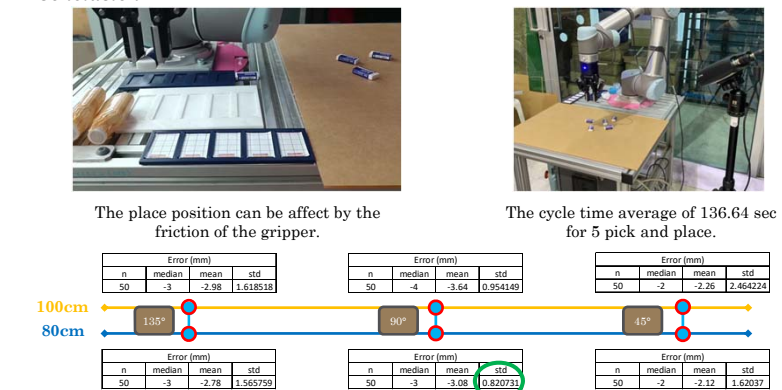
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## Conclusion



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## Conclusion

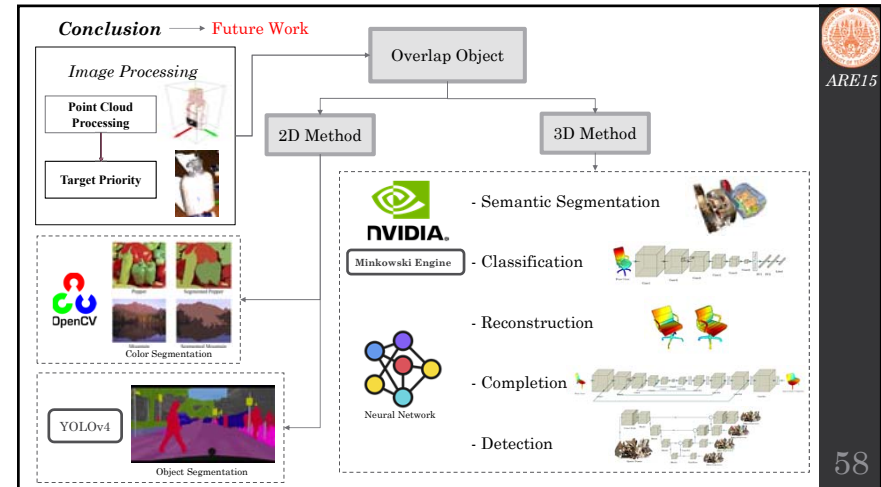
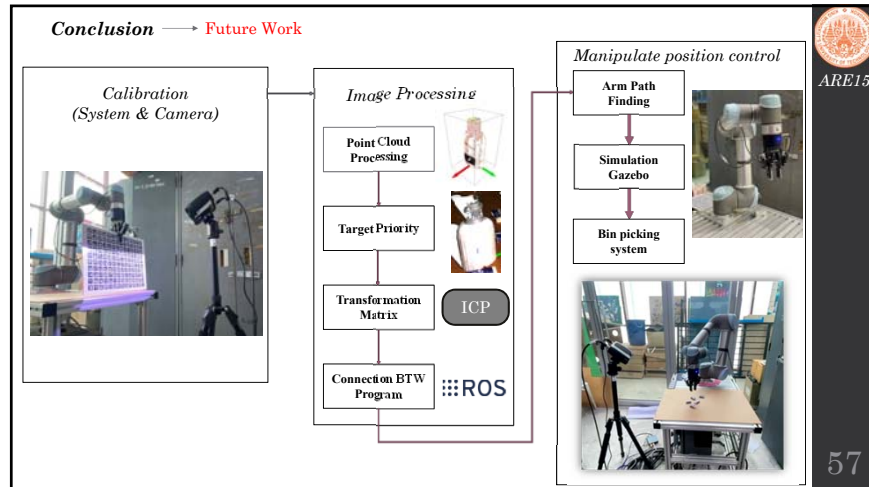


The more near object to the camera focus, the lower standard deviation.  
The angle can affected the standard deviation.



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## Reference

- [1]Ching-Chang Wong , Chi-Yi Tsai , Ren-Jie Chen , Shao-Yu Chien , Yi-He Yang , Shang-Wen Wong , and Chun-An Yeh. Generic Development of Bin Pick-and-Place System Based on Robot Operating System. 2022
- [2]Noppadol Pudchuen and Wisanu Jitviriyai. 3-D Mapping and Localization using RGB-D Camera. 2019
- [3]Ching-Chang Wong , Chi-Yi Tsai , Ren-Jie Chen , Shao-Yu Chien , Yi-He Yang , Shang-Wen Wong , and Chun-An Yeh. Generic Development of Bin Pick-and-Place System Based on Robot Operating System. 2022
- [4]Takuya Tsujibayashi, Katsufumi Inoue, and Michifumi Yoshioka. Normal Estimation of Surface in PointCloud Data for 3D Parts Segmentation. 2018
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