ME400
CAPSTONE DESIGN 1

2ND PRESENTATION

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20160259 Jeongsoo Park

all utopicking BAM

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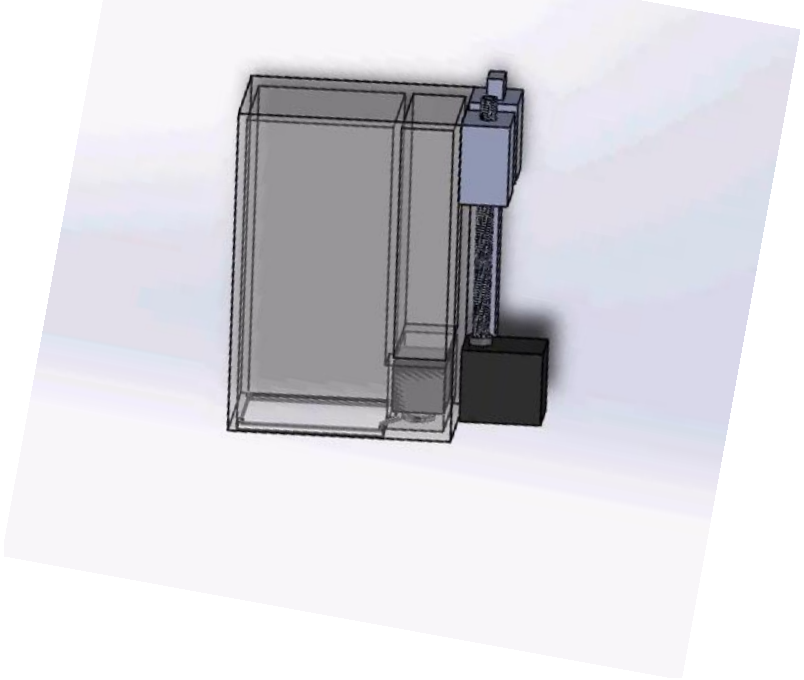
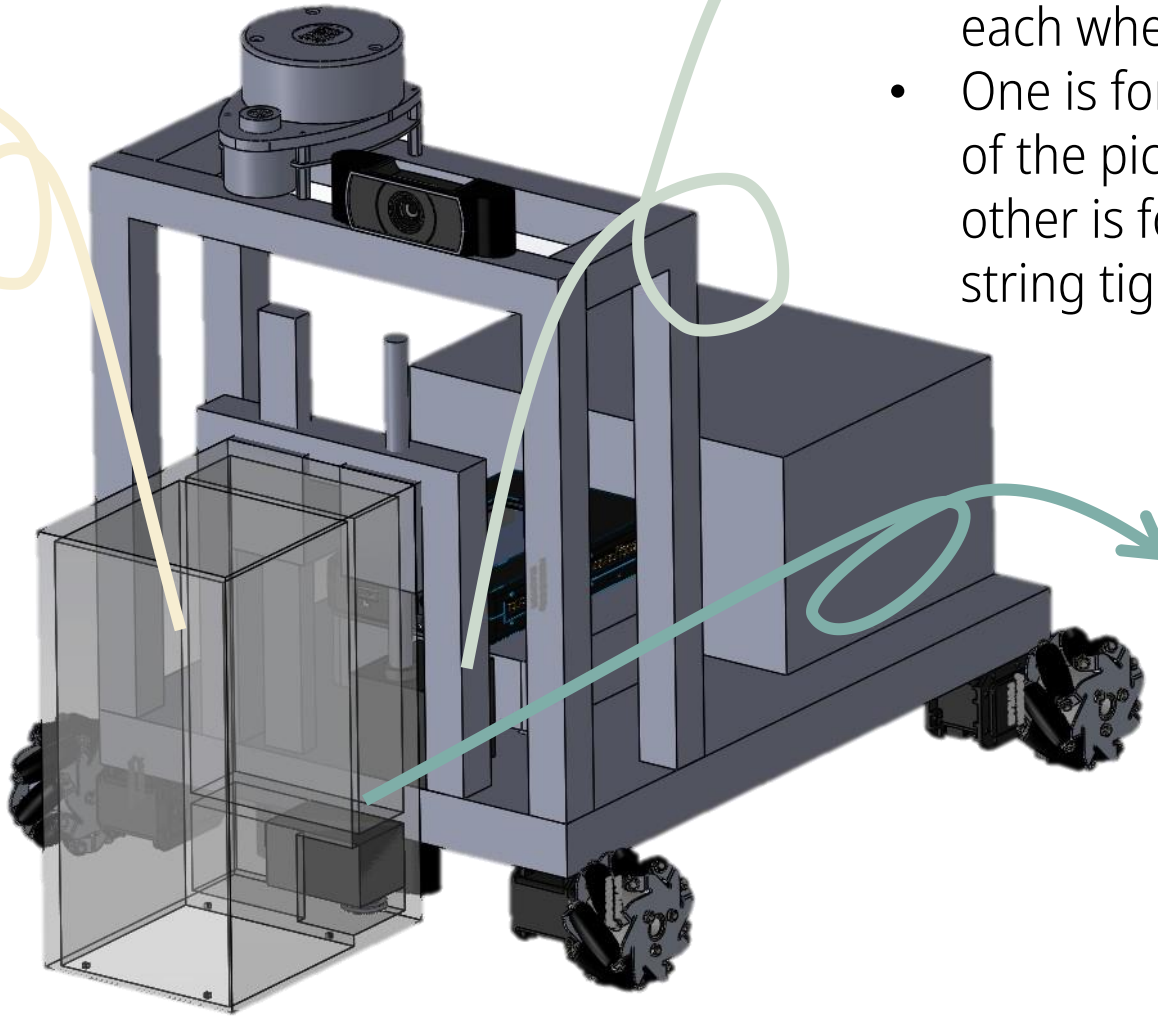
DESIGN REVIEW

PICK-UP PART

- Moving up and down to pick up the ball
- Loosen and tighten the string to pick, hold and release the ball





EXTRA MOTORS

- Two more motors will be used in addition to four for each wheel
- One is for vertical translation of the picking part and the other is for adjusting the string tightness.

EXTRA CAMERA

Second camera will be used for delicate control when the car is close to the ball

GOAL

COMMON GOAL

Control the mobile platform by Xbox controller

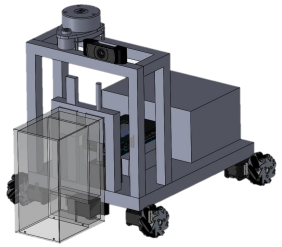
OUR GOAL!!

Ball detection and corresponding movement toward the ball

Implementation of the pick-up part

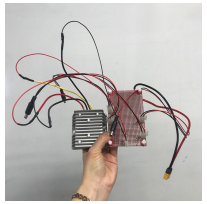
Separately!

ROAD MAP

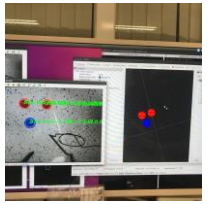


Design Feedback (1st presentation)

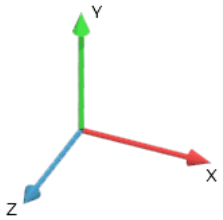
TEST 1: Control of omniwheel/dynmixel with xbox controller by Labview



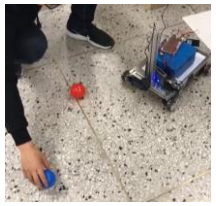
Circuit configuration and soldering



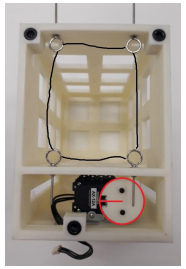
Integration of OpenCV and ROS



Transfer matrix and control code by ROS



Auto driving implementation by ROS, LabVIEW and OpenCV



Pick-up part prototype 1

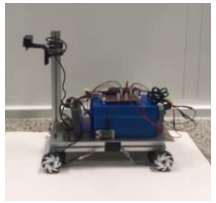
Hardware prototype 1: ZARA

Hardware 3D printing: Pick-up prototype

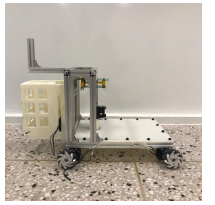
Pick-up part prototype refinement

OpenCV code revision

TEST 2: Control of the mobile platform powered by battery and controlled by xbox



Pick-up mechanism implementation by LabVIEW



TASKS

Task 1

Dynamixel Control with Xbox Controller

Task 2

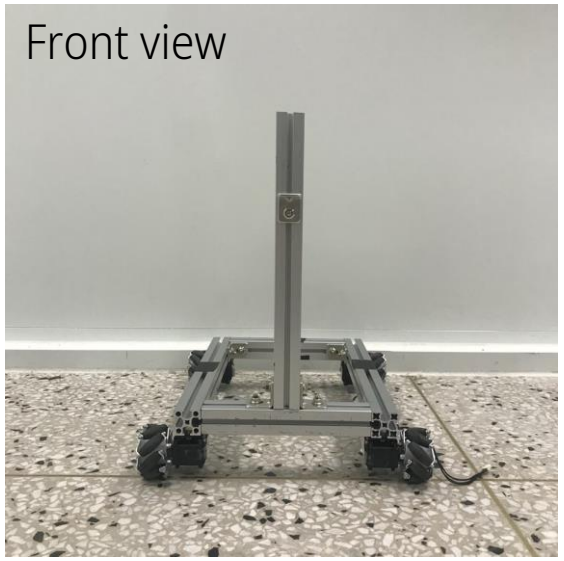
Autonomous Ball Tracking

Task 3

Implementation of Pick-up Part

TASK 1:
Dynamixel Control with Xbox Controller

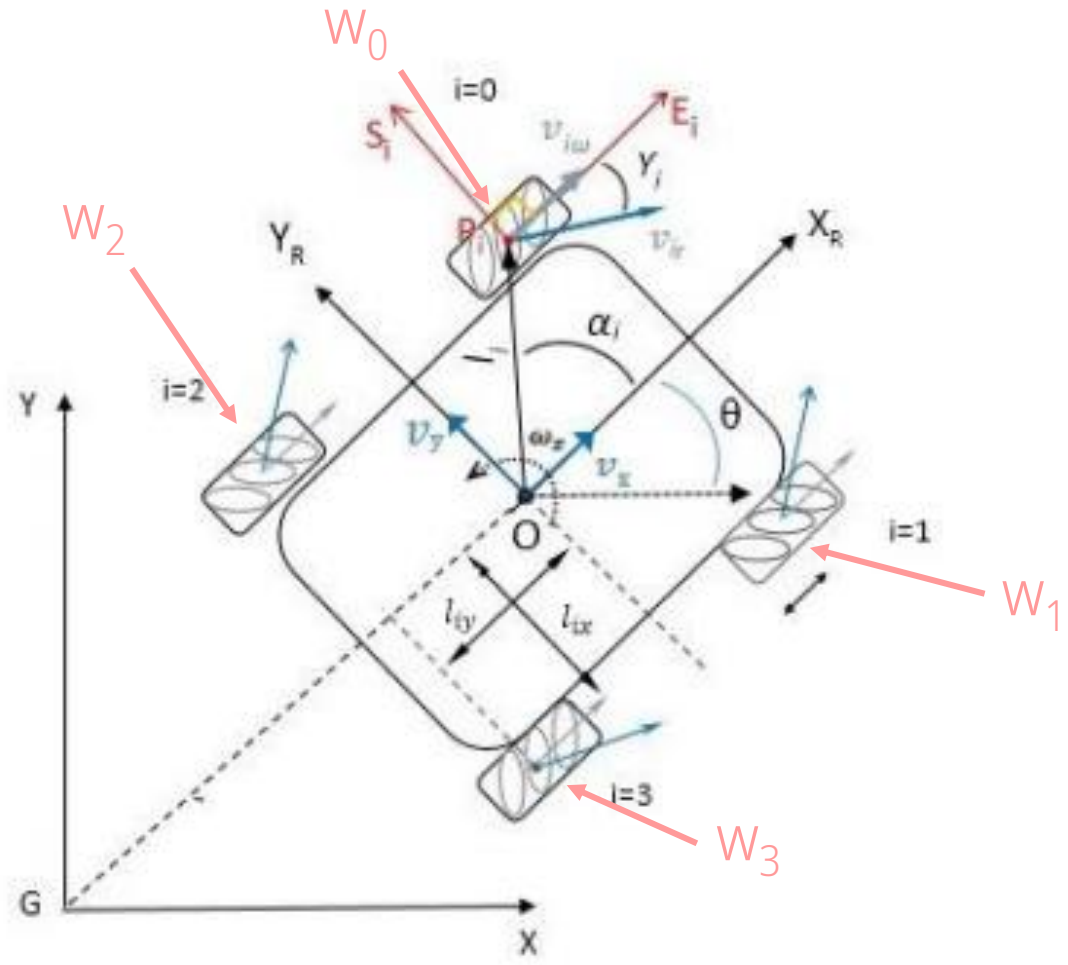
HARDWARE PROTOTYPE 1: ZARA



30 x 30 aluminum profile
Dynamixel x 4
Omniwheel x 4

Frame mass : 3.21kg
Frame size : 25×35×30(cm)

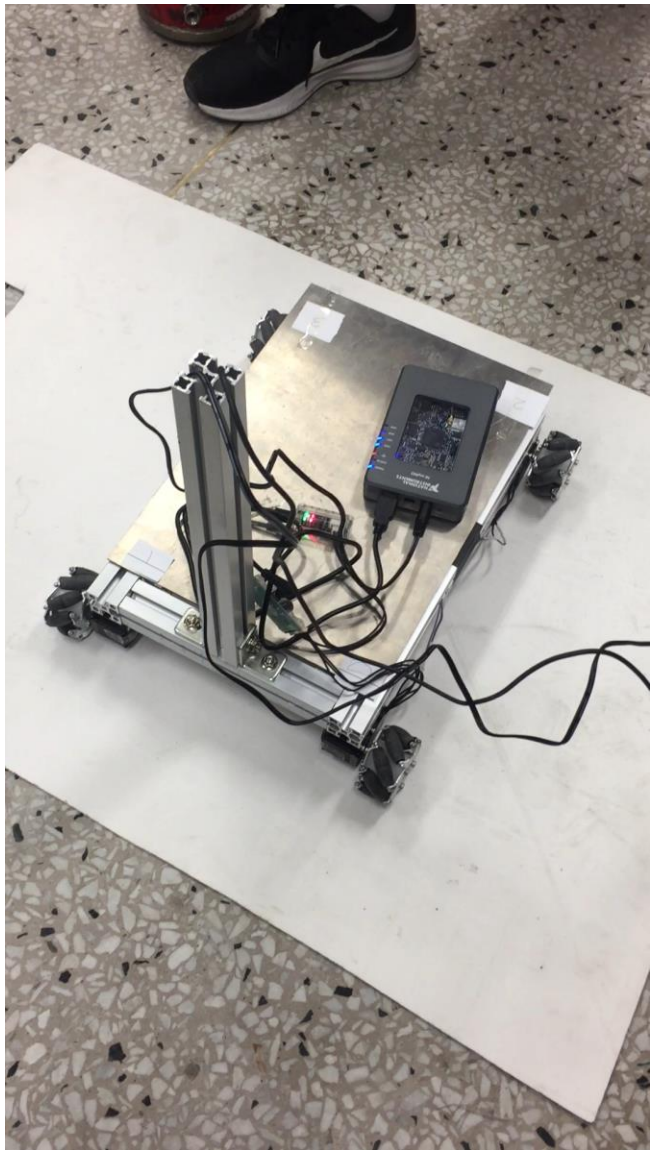
LABVIEW CODE



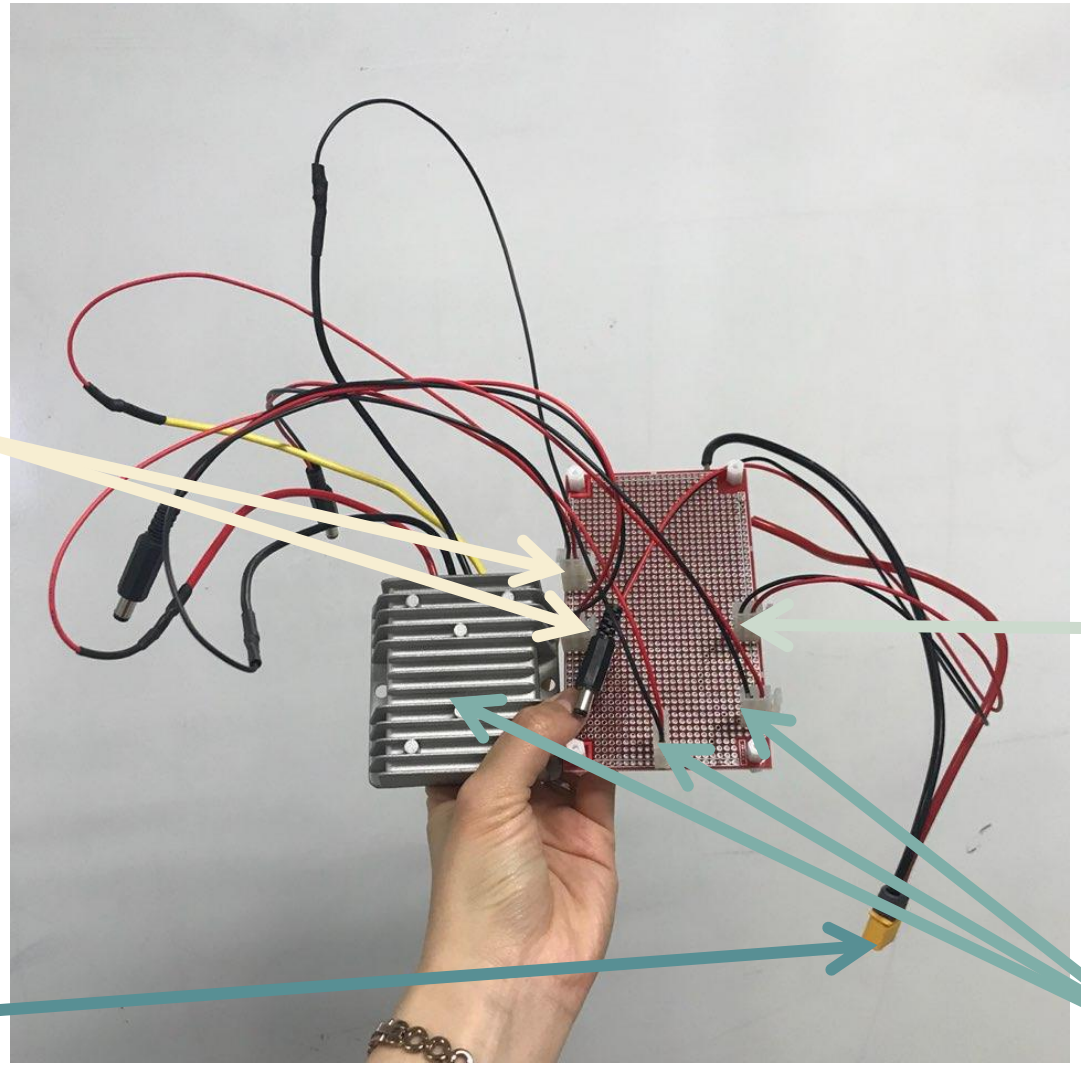
i) State==0 (Driving mode)

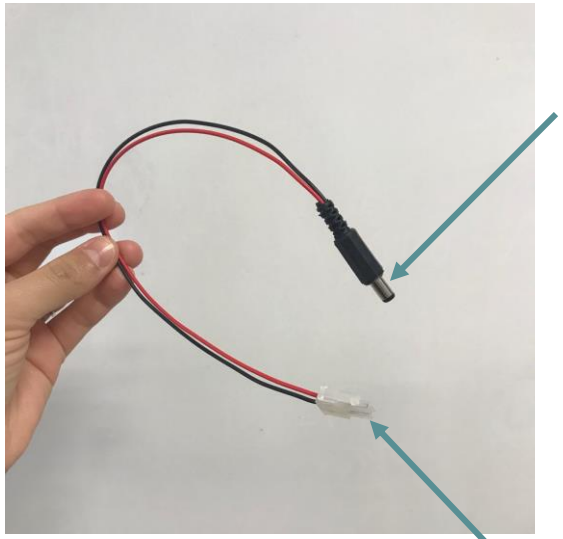
Moving Robot with 4 driving motors (receive w_0, w_1, w_2, w_3 data from Ros client within 10ms)

TEST 1: DYNAMIXEL CONTROL WITH XBOX CONTROLLER



CIRCUIT CONFIGURATION AND SOLDERING





Dynamixel and MyRio (12V)

NUC (19V)

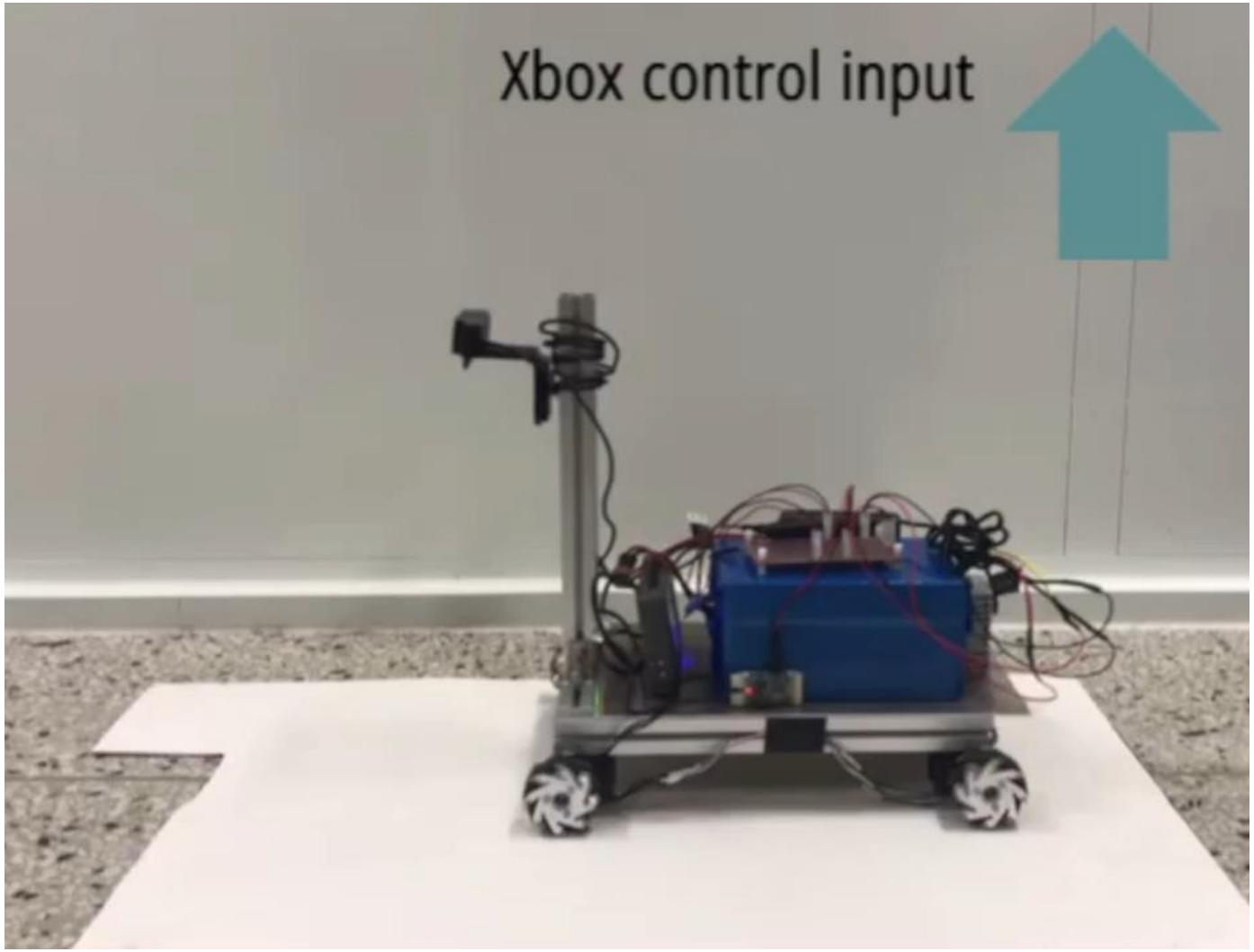
Connect to the devices

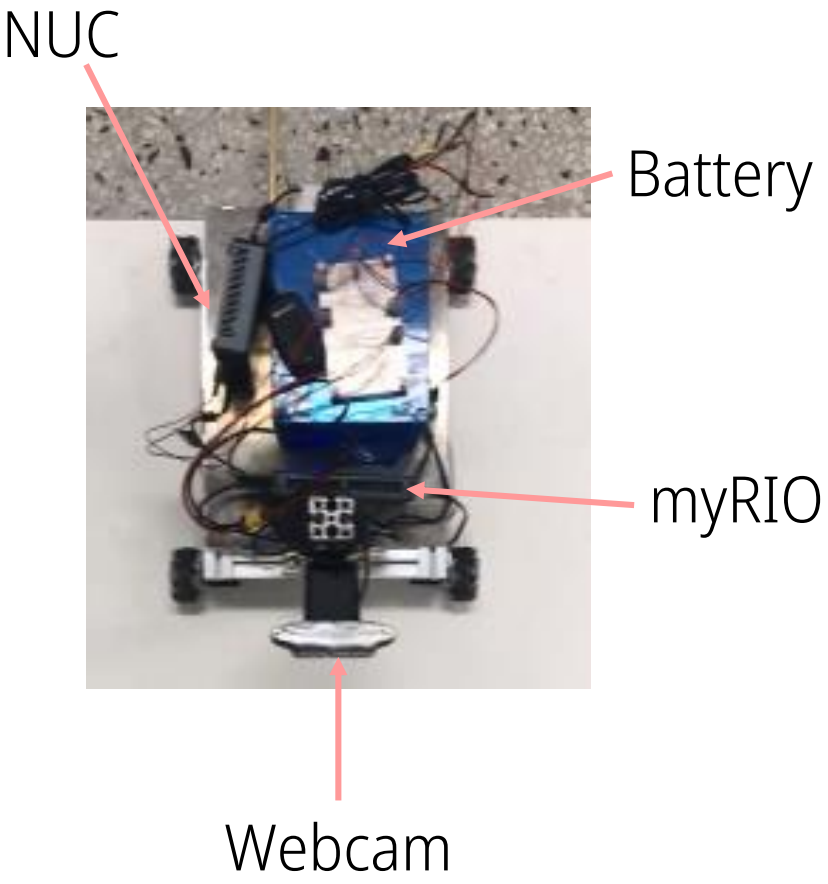
Connect to the breadboard

Power line - Connected to battery

Convertor (24V → 12V)

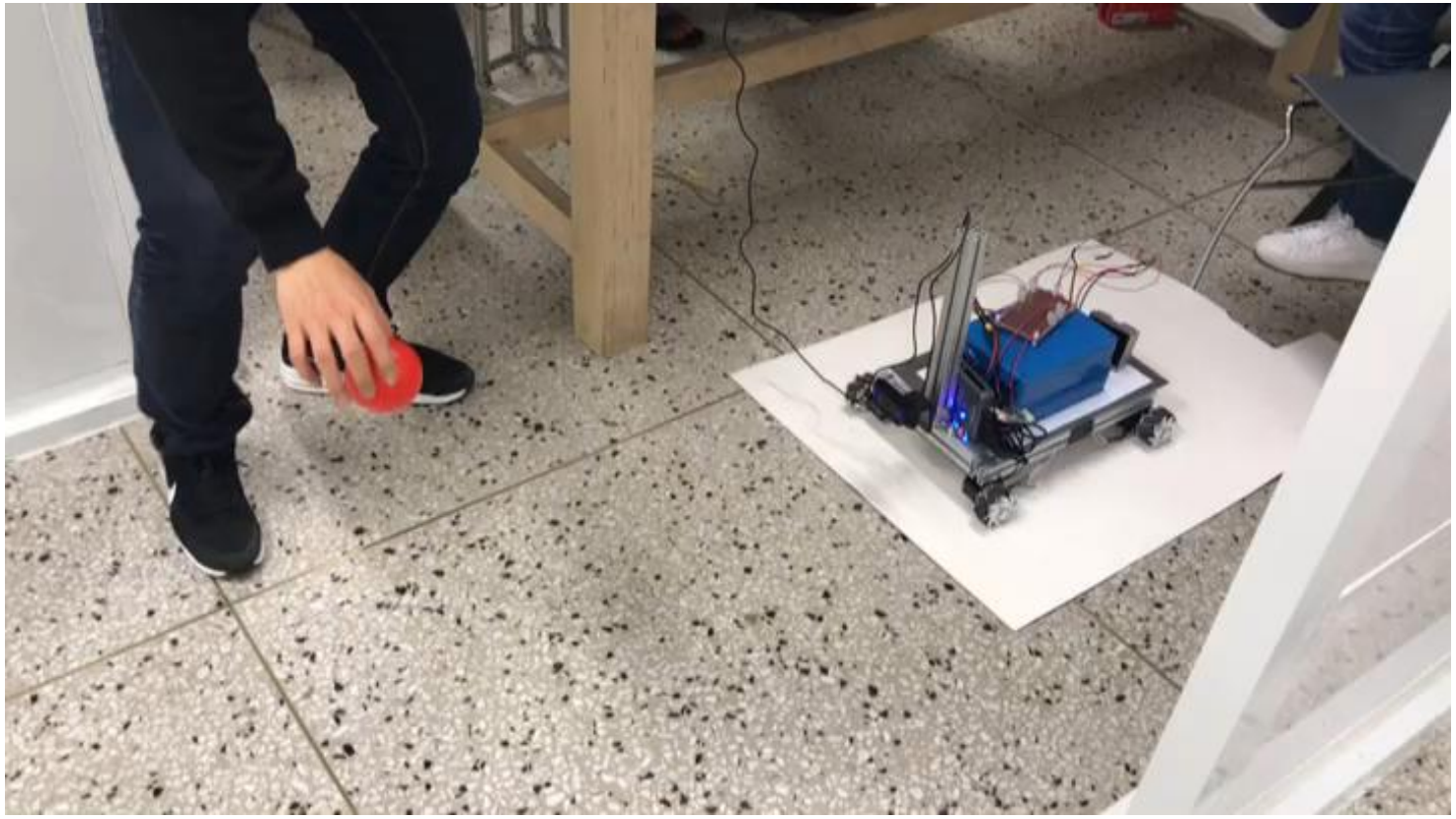
TEST 2: CONTROL OF THE MOBILE PLATFORM POWRED BY BATTERY AND CONTROLLED BY XBOX

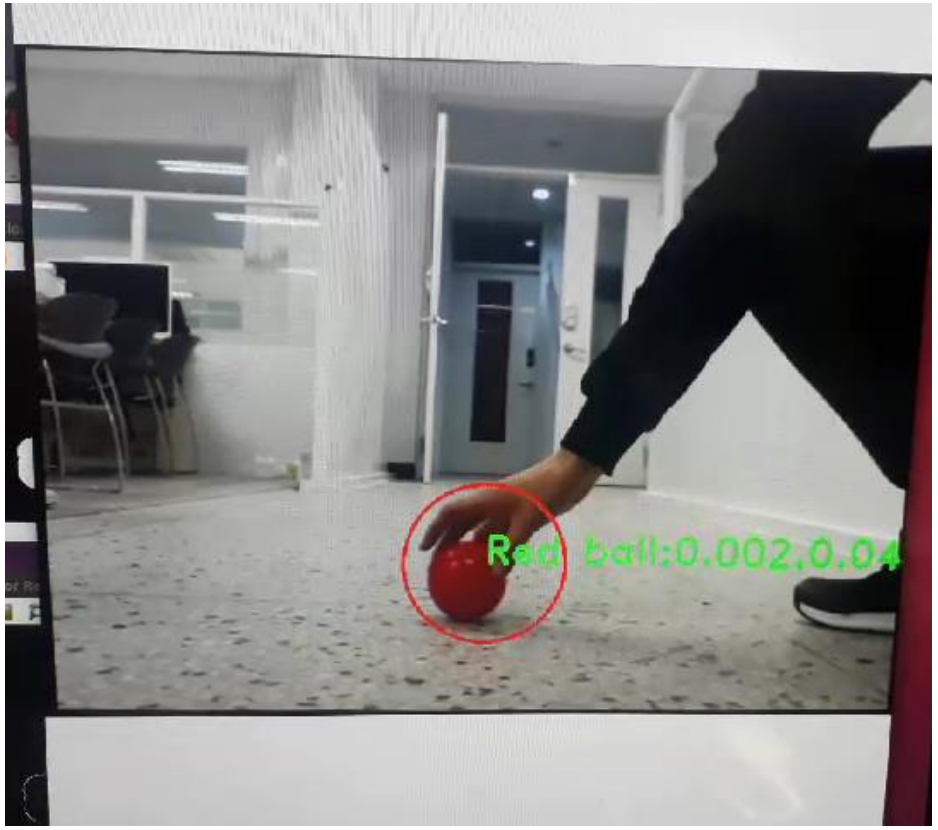




TASK 2:
AUTONOMOUS BALL TRACKING

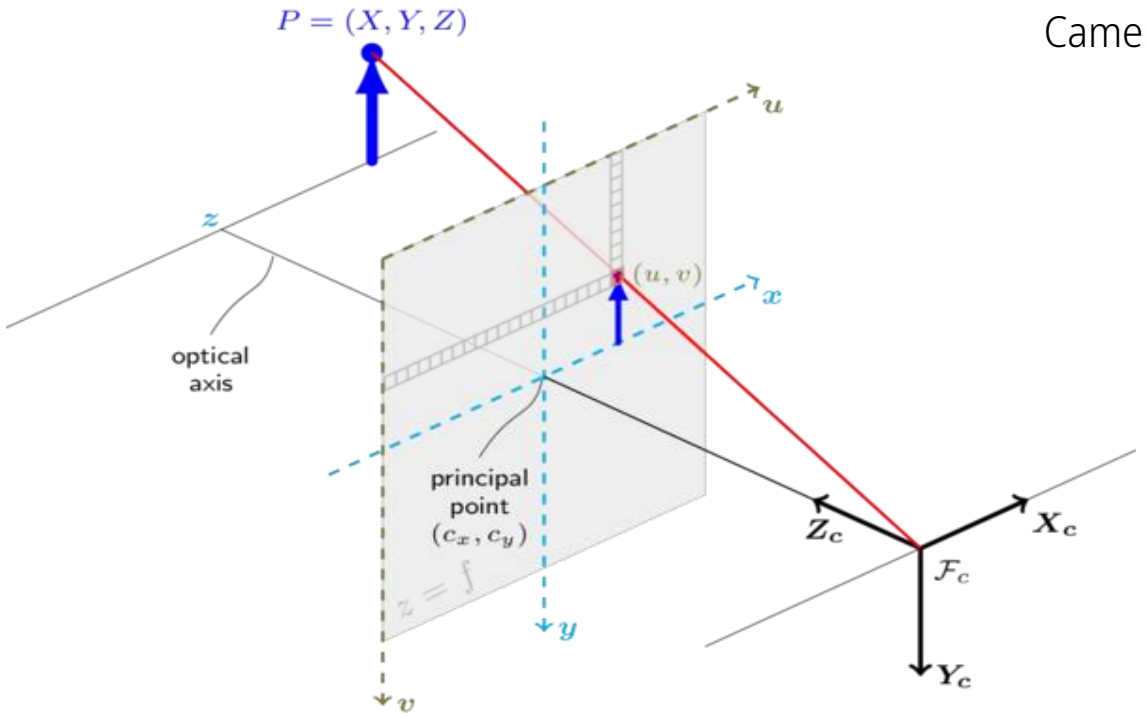
BALL TRACKING WITH ZARA





OPENCV CODE

Evaluating Points in 3D Using Camera Coordinates:



Camera Calibration Matrix:

$$K = \begin{bmatrix} F_x & 0 & c_x \\ 0 & F_y & c_y \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 636.792913 & 0 & 329.63907 \\ 0, & 635.580978 & 238.191252 \\ 0 & 0 & 1 \end{bmatrix}$$

$F_x \approx F_y$

$$d = \frac{D \times F}{P}$$

(distance from camera)

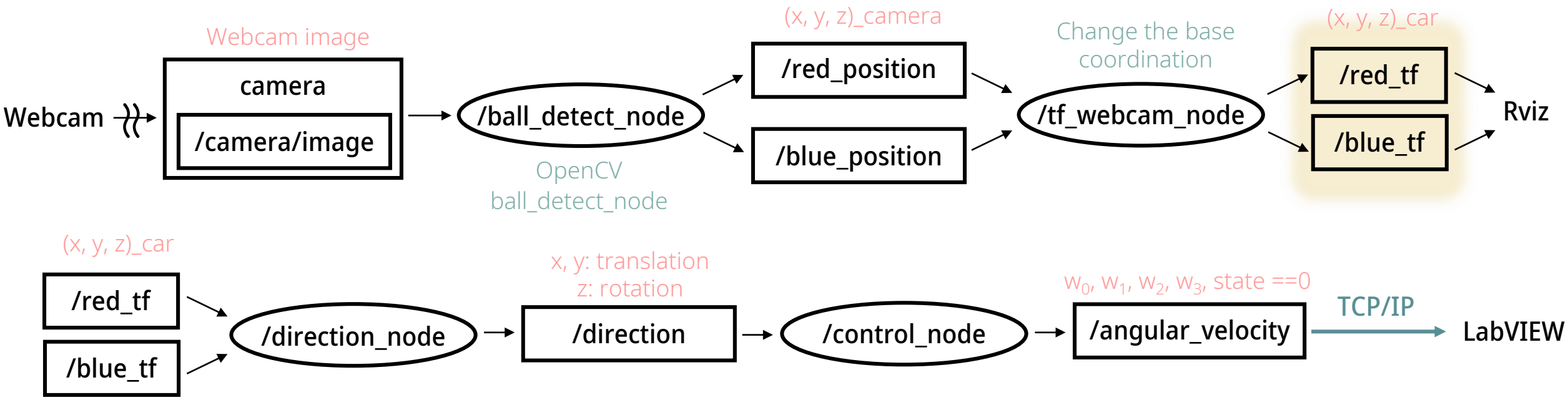
P: diameter of object in pixels

- In pixel coordinates: $u = (\frac{x - U_o}{F_x})$ $v = (\frac{y - V_o}{F_y})$
- Distance along Z_C: $Z_C = \frac{(F_x * D)}{P}$

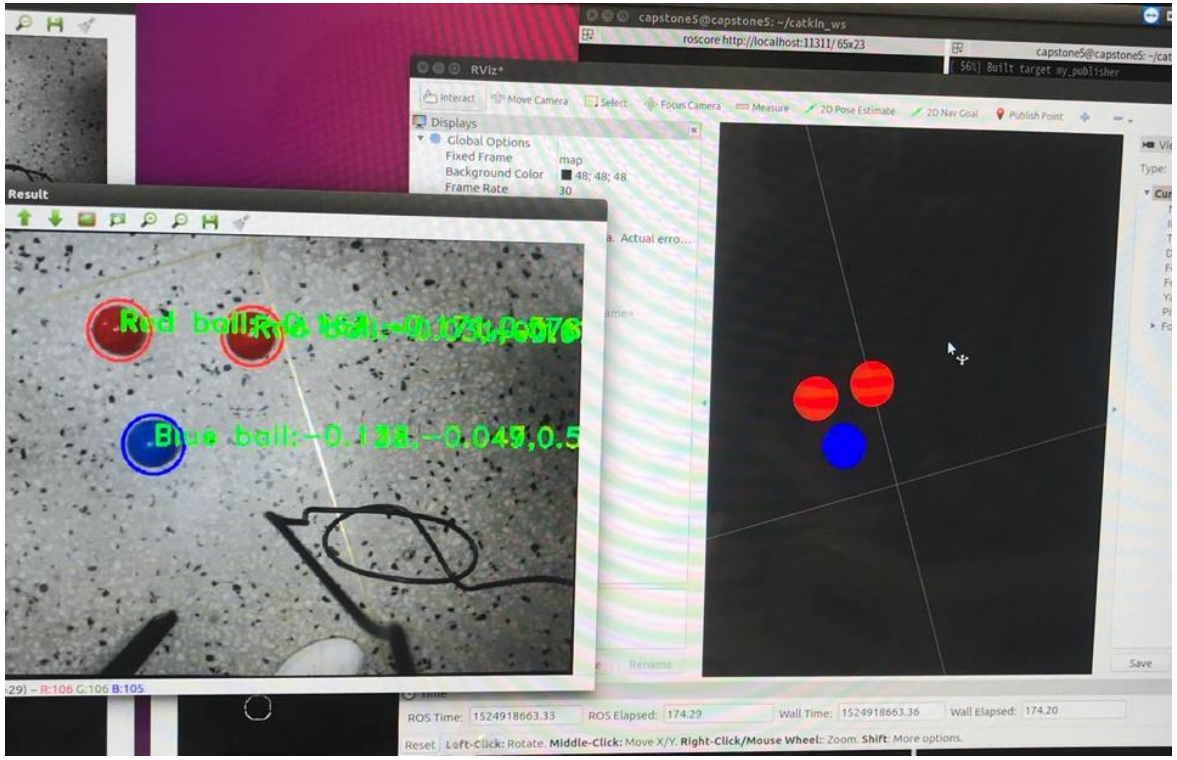
Reconstructed 3D coordinates:
(using triangle similarity)

$$X_C = u * Z_C\,, \qquad Y_C = v * Z_C\,, \qquad Z_C$$

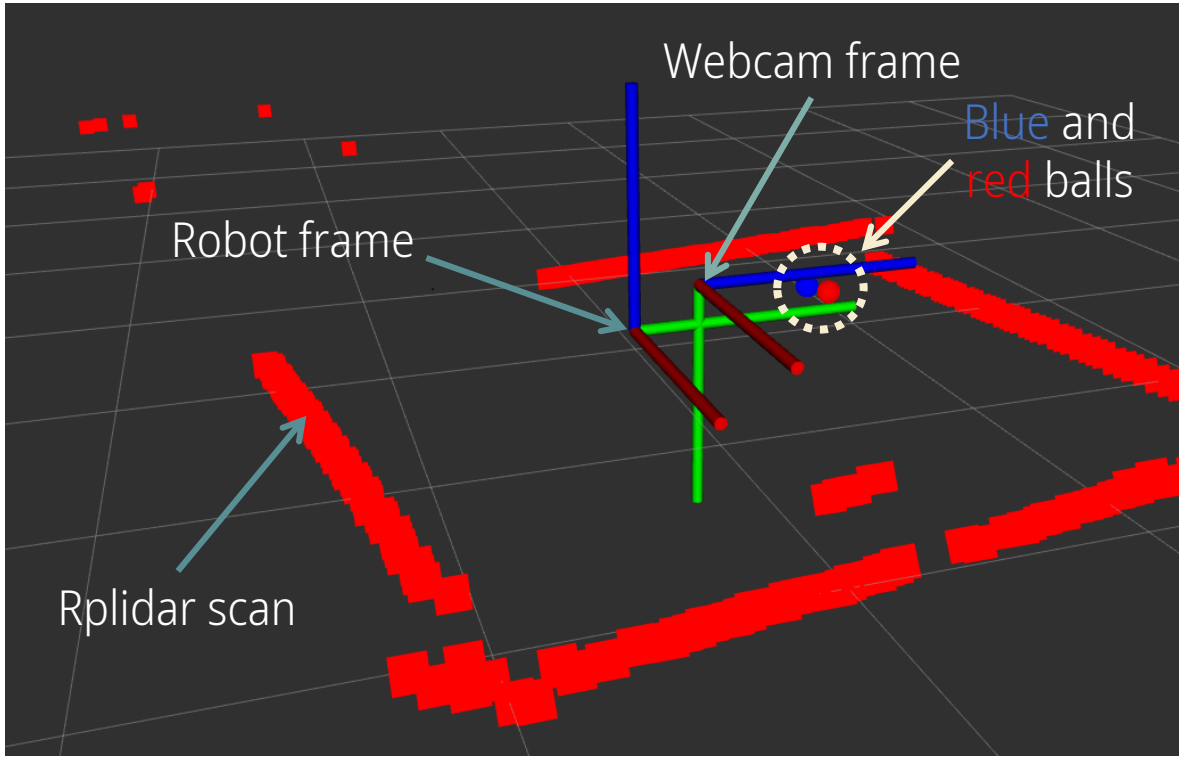
TRANSFER MATRIX AND CONTROL CODE BY ROS



INTEGRATION OF OPENCV AND ROS



Camera screen and corresponding markers in Rviz

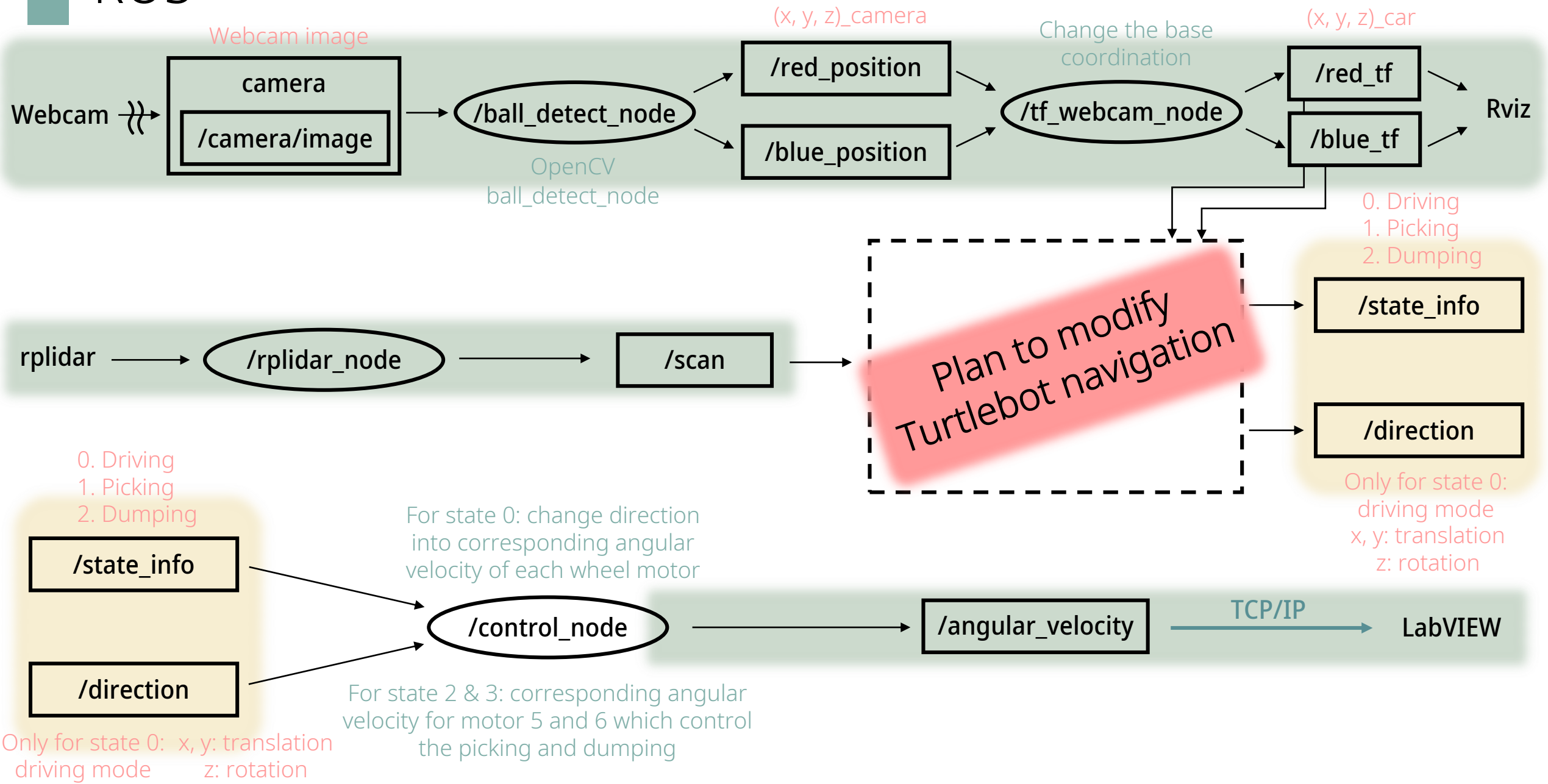


Integration of frames, markers and Rplidar output

FUTURE WORK

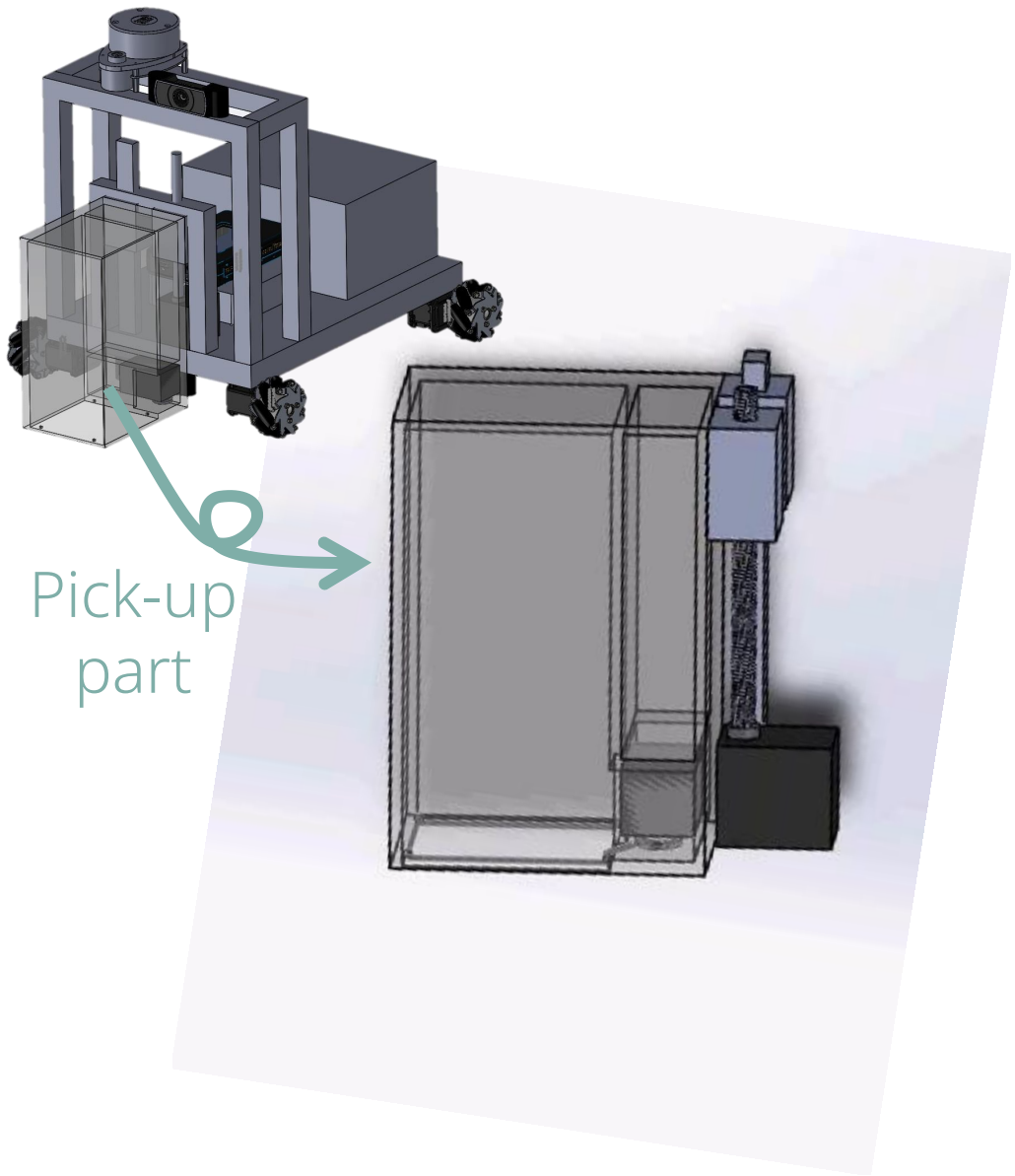
	1. Detection and Path Generation	2. Picking up the balls	3. Dropping off the balls
Opencv	More accurate detection of balls' contours	Use the second webcam to detect ball under the pickup part	Detecting green ball on the basket
ROS	Make algorithm to avoid walls and red balls	Matching the position of pickup part and blue ball	Go back to the basket after picking up 3 blue balls

ROS


Webcam image
(x, y, z)_camera
Change the base coordination
(x, y, z)_car
Webcam
camera
/camera/image
/ball_detect_node
OpenCV ball_detect_node
/red_position
/blue_position
/tf_webcam_node
/red_tf
/blue_tf
Rviz
rplidar
/rplidar_node
/scan
Plan to modify Turtlebot navigation
0. Driving
1. Picking
2. Dumping
/state_info
/direction
Only for state 0: driving mode
x, y: translation
z: rotation
0. Driving
1. Picking
2. Dumping
/state_info
/direction
Only for state 0: driving mode
x, y: translation
z: rotation
For state 0: change direction into corresponding angular velocity of each wheel motor
/control_node
For state 2 & 3: corresponding angular velocity for motor 5 and 6 which control the picking and dumping
/angular_velocity
TCP/IP
LabVIEW

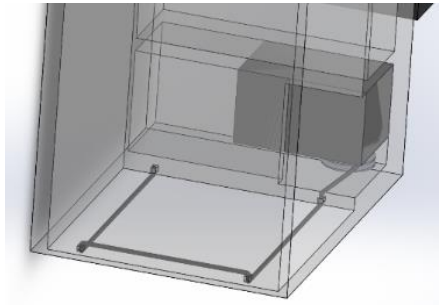
TASK 3:
IMPLEMENTATION OF PICK-UP PART

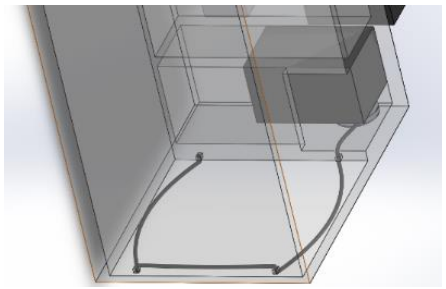
PICK-UP PART

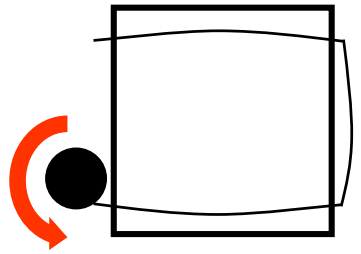


One subsystem

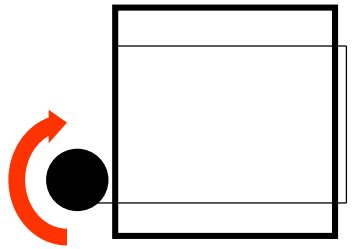
- Pick up the ball
- Store the ball
- Dump the ball





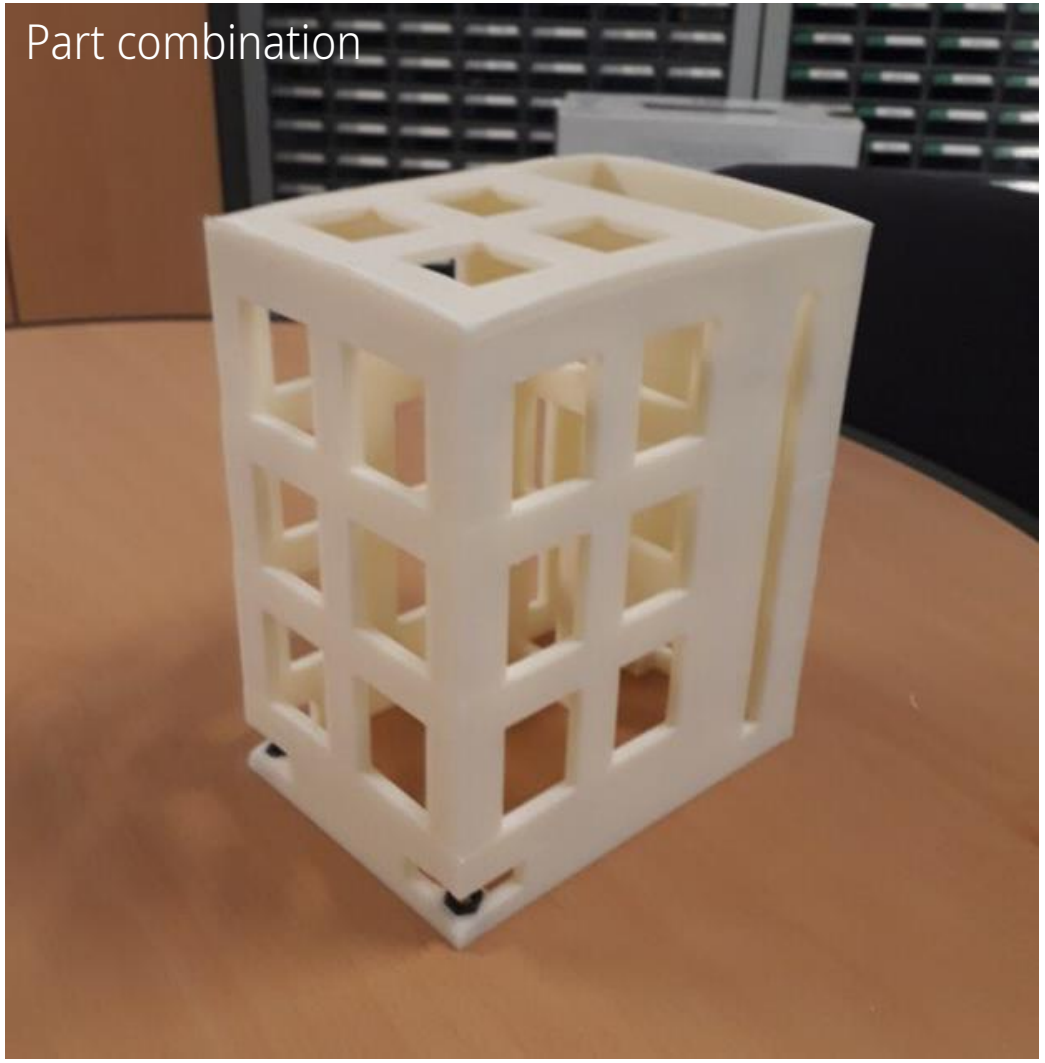


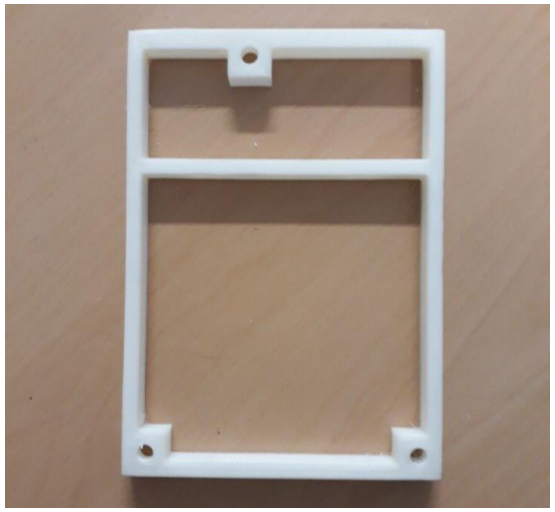
Loosen the string



Tighten the string

PICK-UP PART PRODUCTION



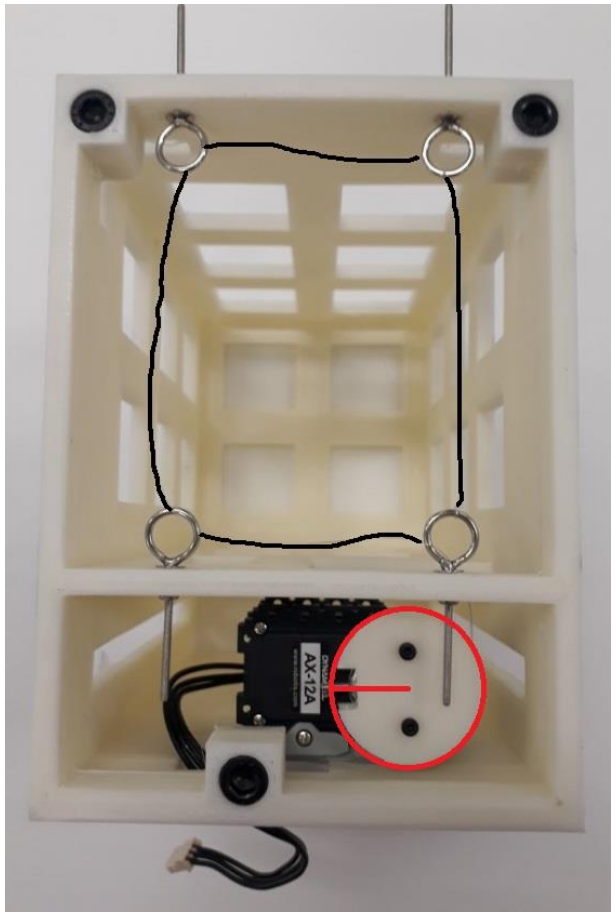


Pick-up body

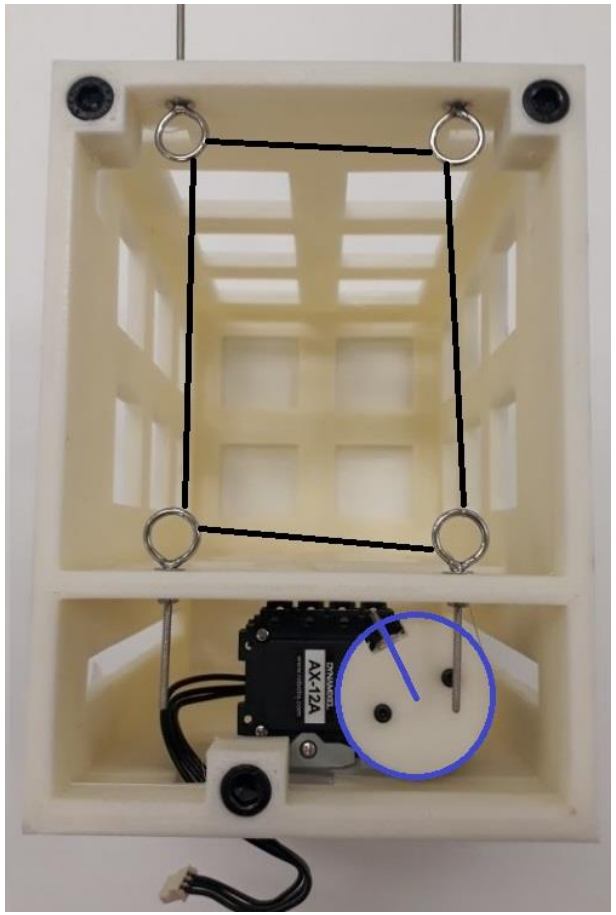
3D printing
material: ABS
mass: 450g

STRING ADJUSTING MECHANISM

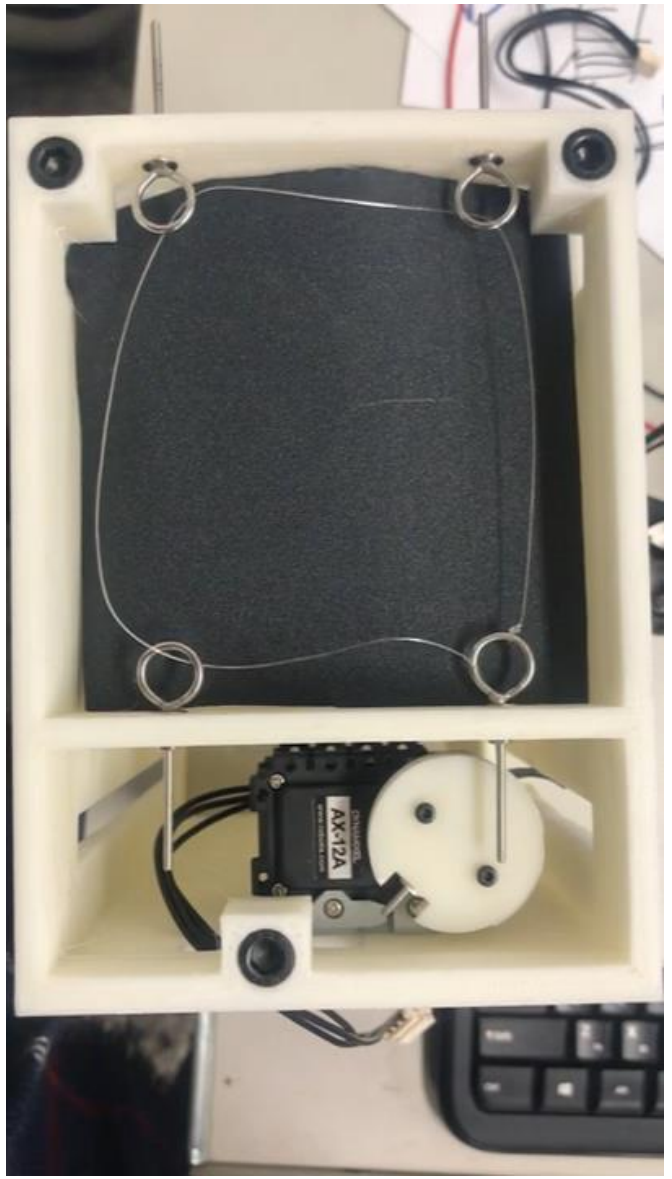
Loosen the string



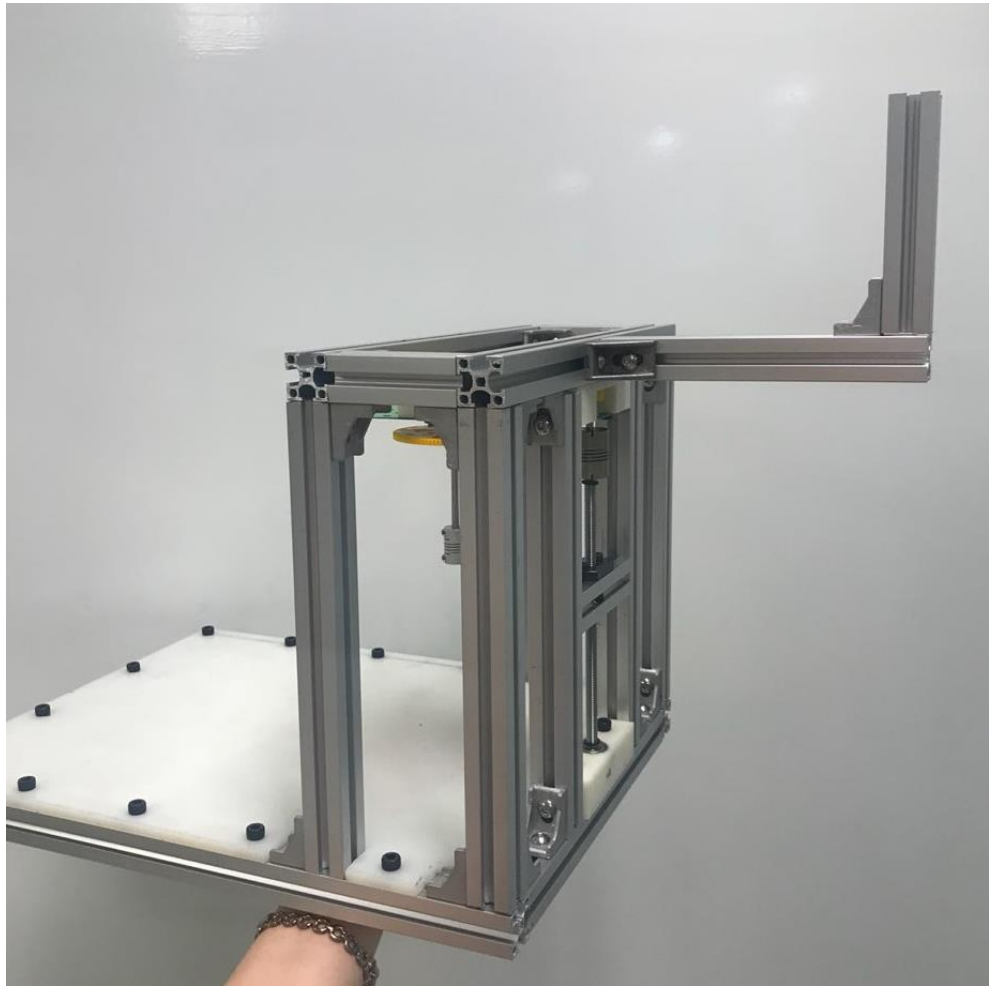
Tighten the string



Dynamixel - AX 12A



HARDWARE PROTOTYPE 2: NAMSAENG-2



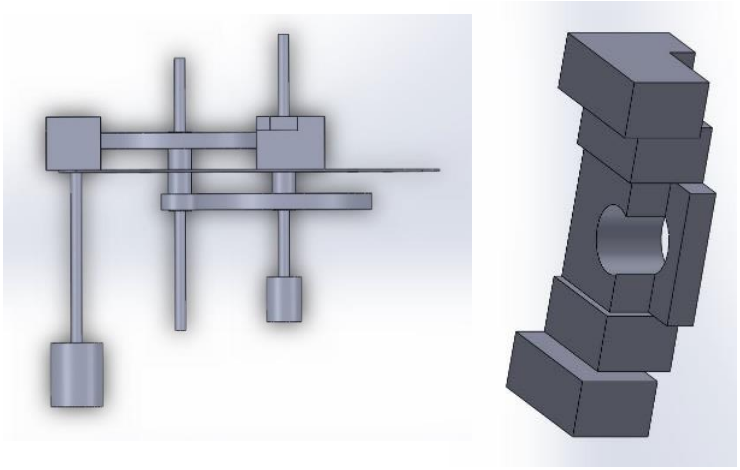
Hardware prototype 2 NAMSAENG-2

Hardware prototype 1
ZARA

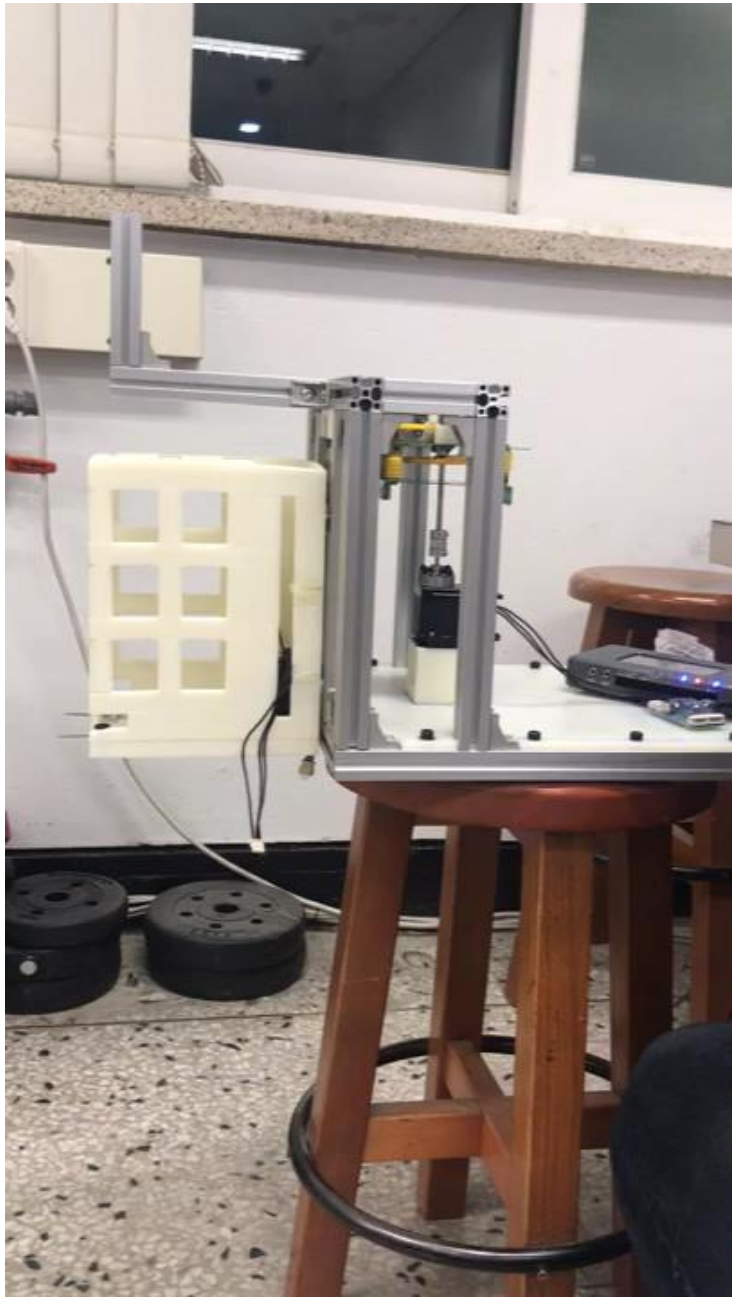
Frame mass : 3.21kg
30 x 30 aluminum profile

Frame mass : 1.29kg
20 x 20 aluminum profile

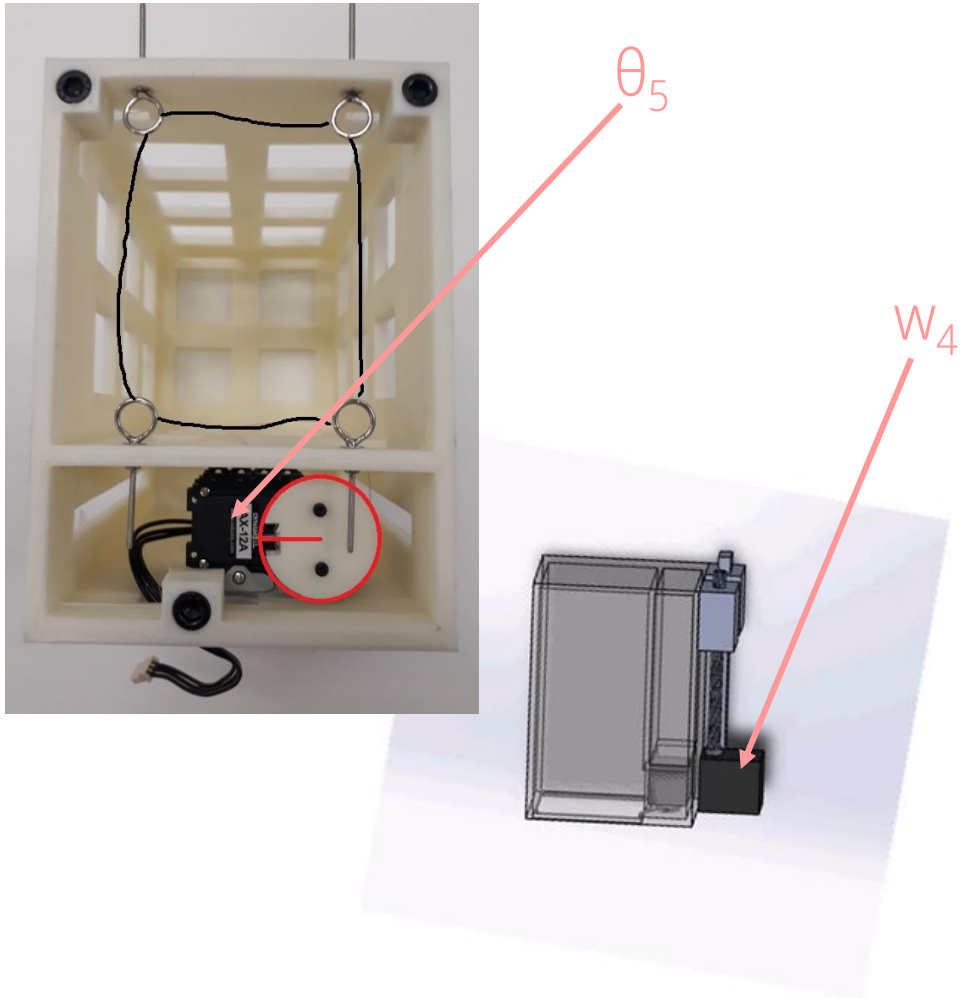
IMPLEMENTATION OF PICK-UP PART



Gear box CAD drawing



PICK-UP MECHANISM IMPLEMENTATION



ii) State==1 (Picking mode)

Stop Robot (set w_0, w_1 , w_2 , w_3 == 0)
Start Picking Operation ::
- myRio does not receive data until Picking Operation ends.
- Control 2 picking motors

String motor with joint mode : θ_5
Pick-up motor with speed mode : w_4

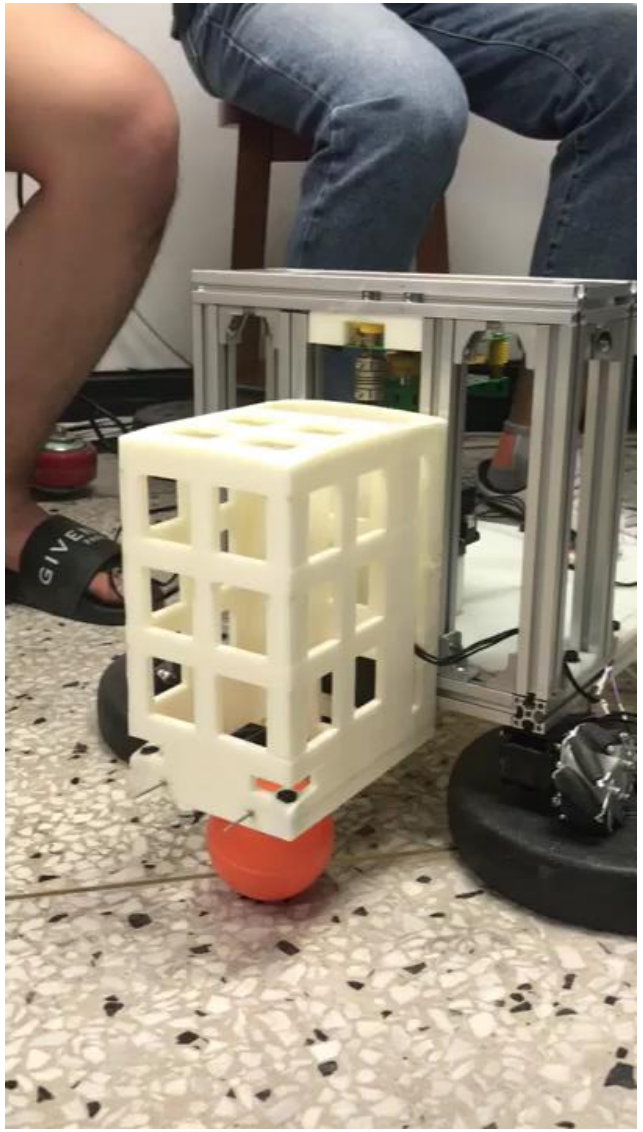
iii) State==2 (Dumping mode)

Control string motor with joint mode : θ_5

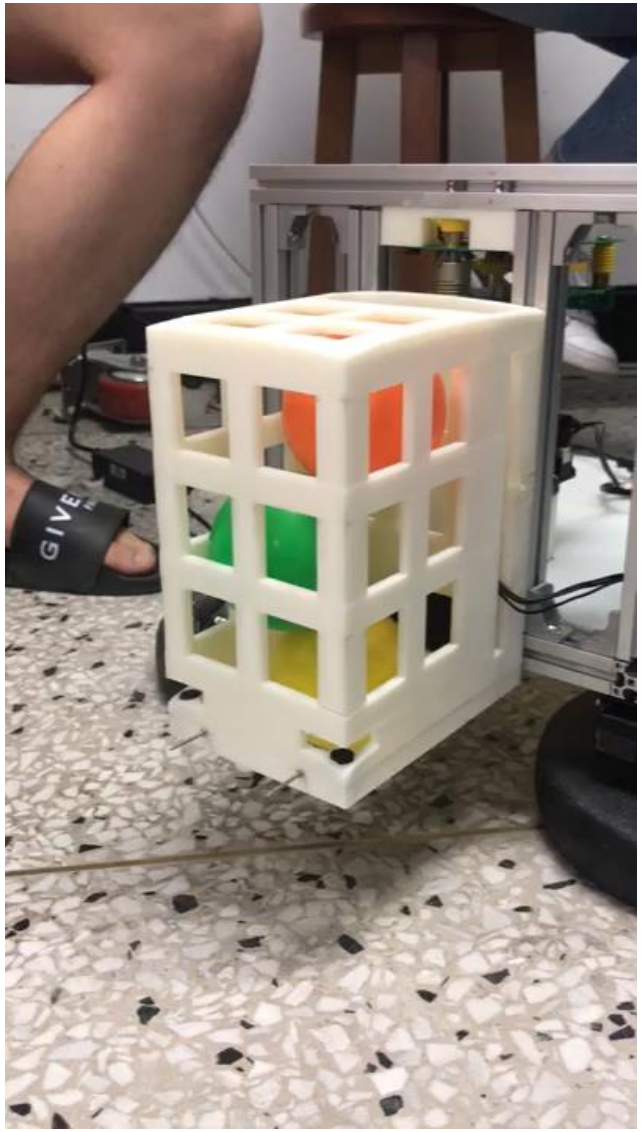
PICKING UP MECHANISM

Ball positioned under the box →

Xbox controller →



Picking up



Dumping

DISCUSSION

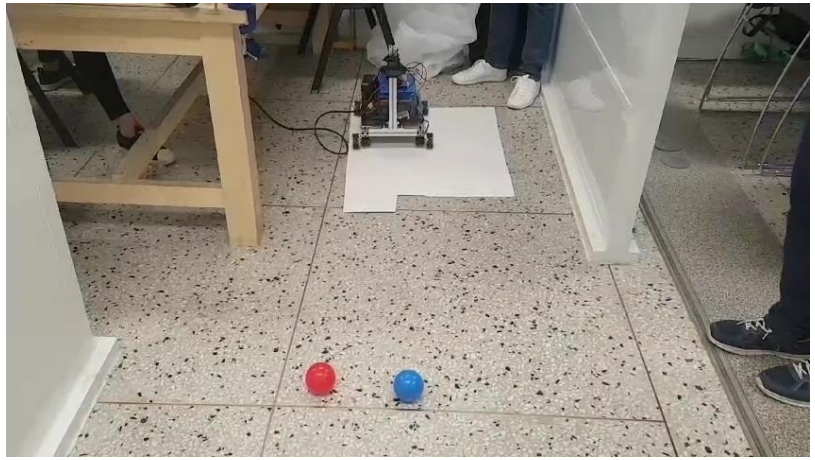
Vibration Reduction

Heat Release

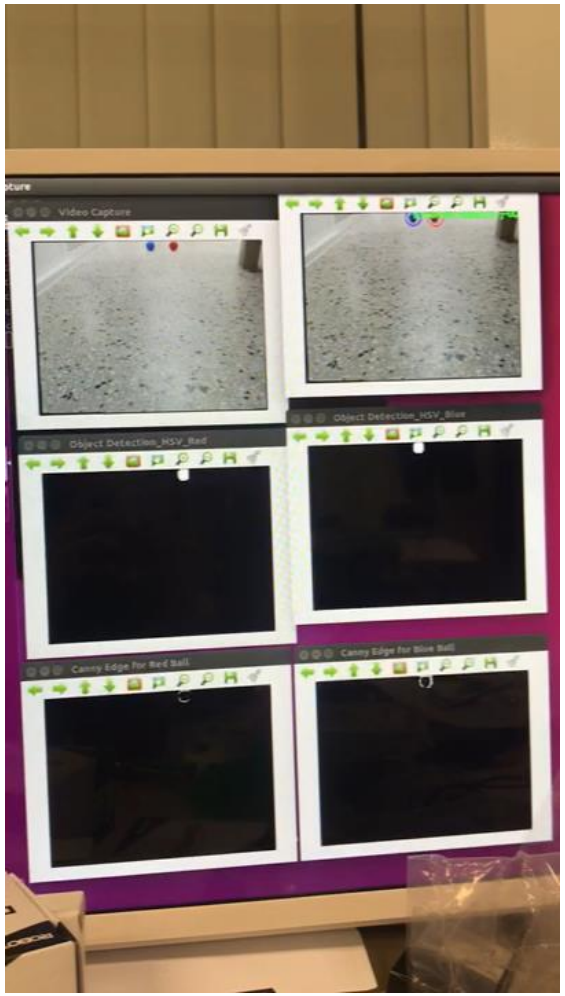
ABOUT VIBRATION REDUCTION

Straight path

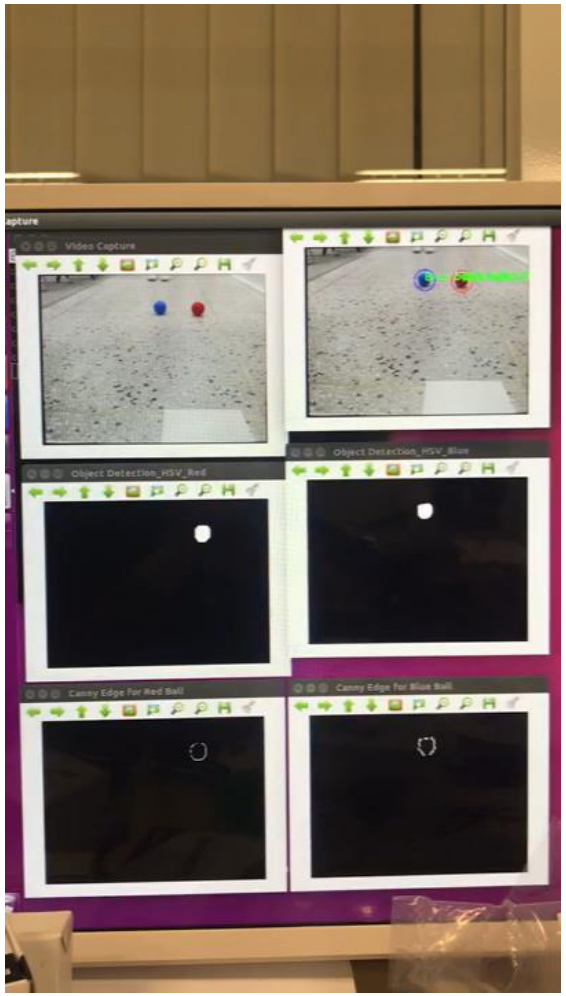
Curved path



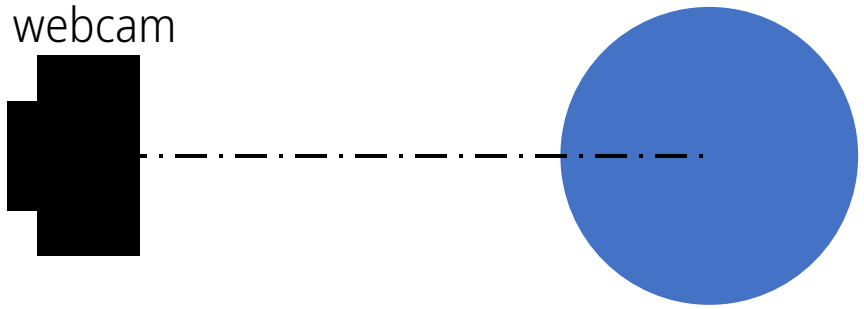
Straight path

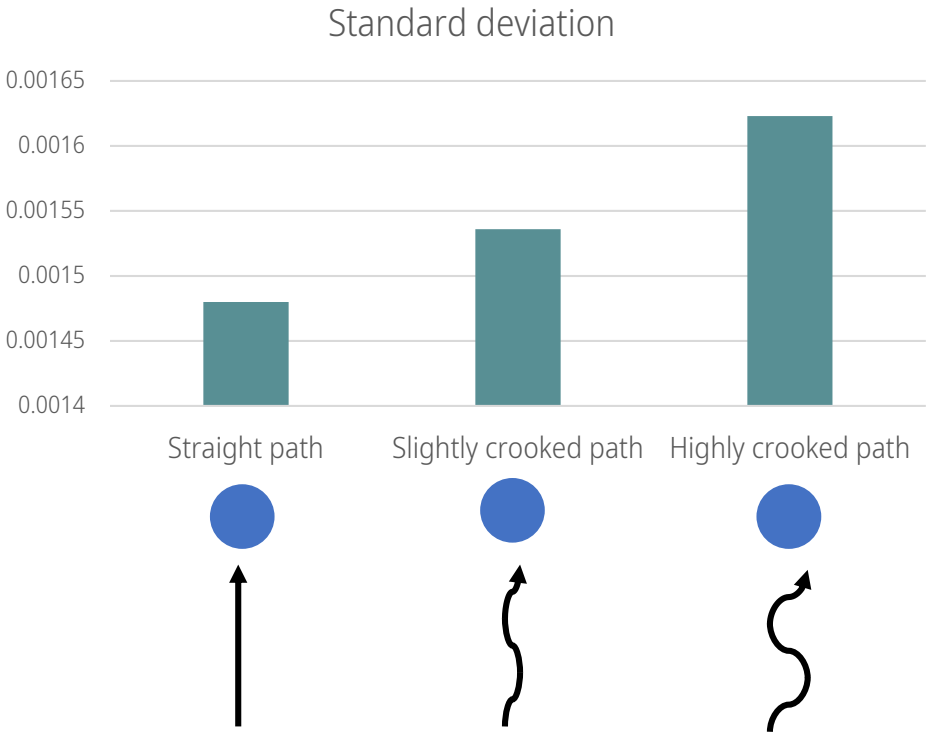


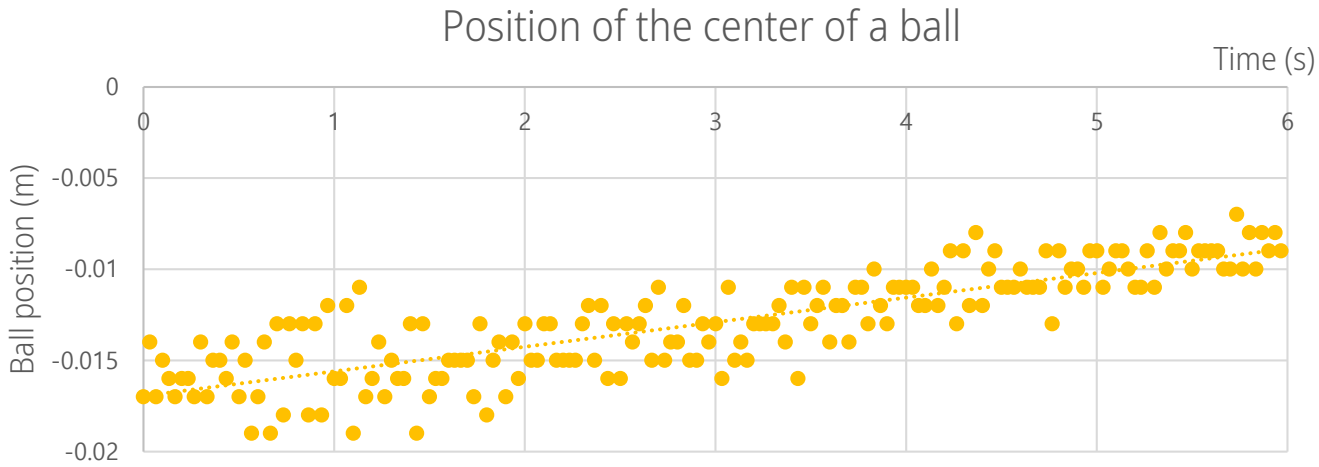
Curved path

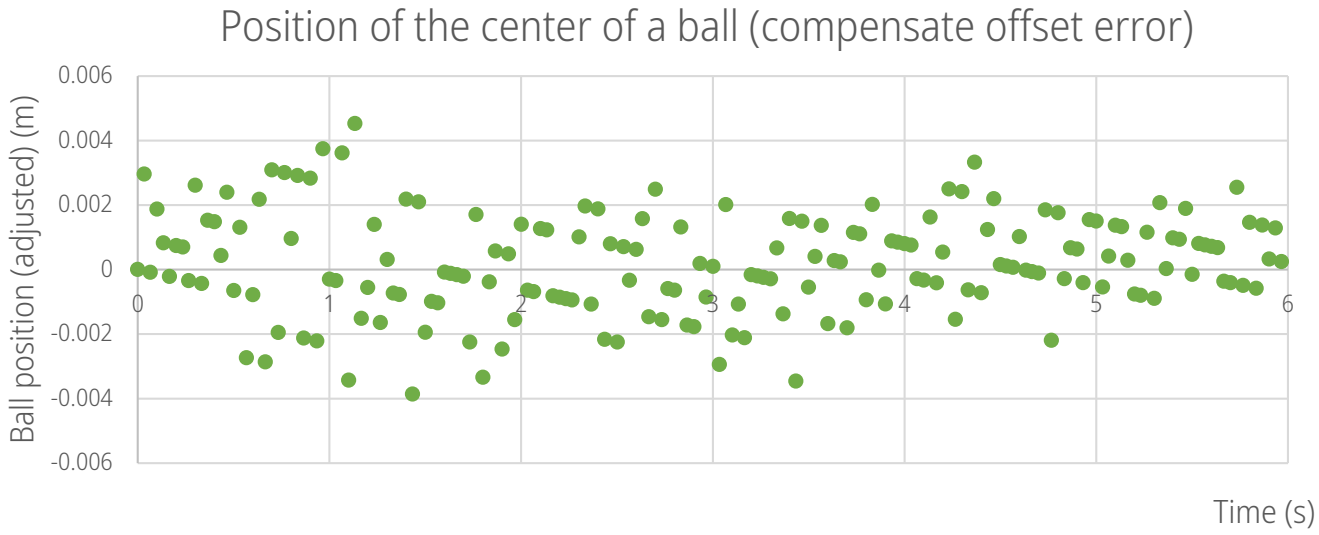


ABOUT VIBRATION REDUCTION





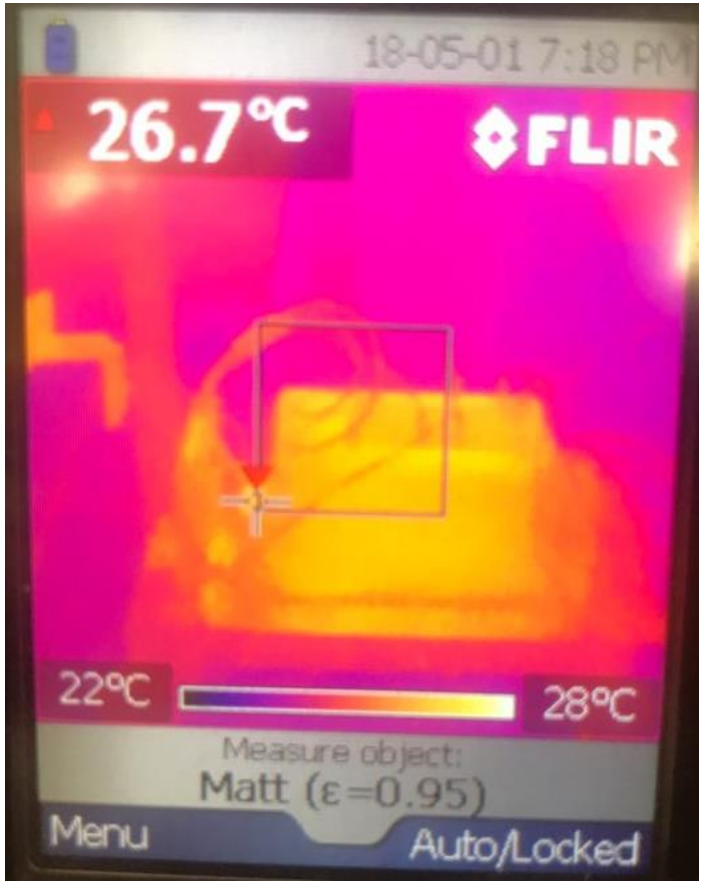




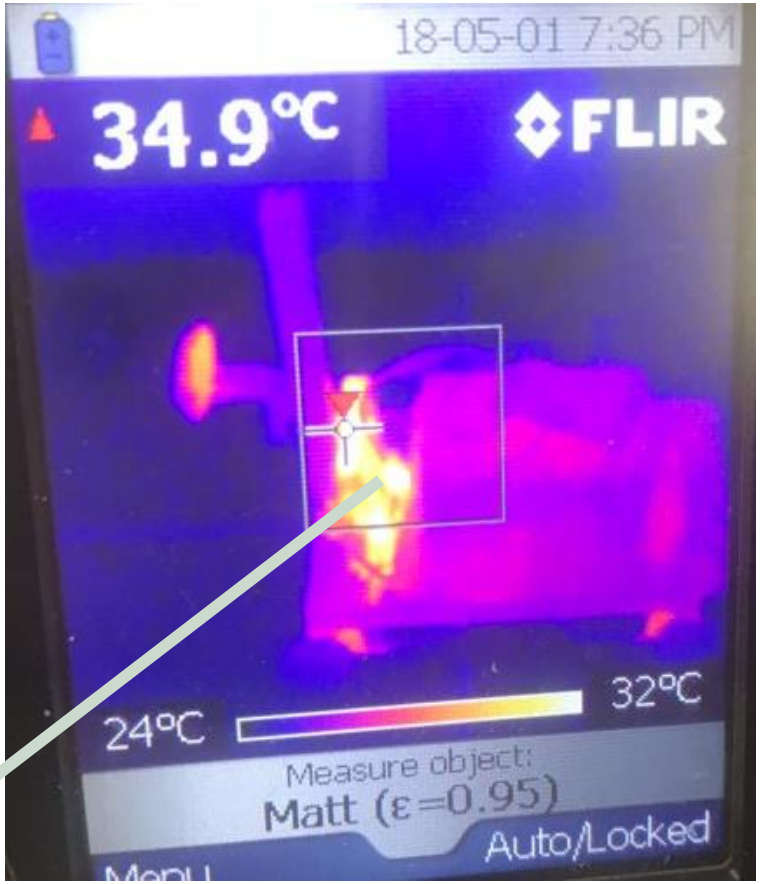
ABOUT HEAT RELEASE

- Using thermal camera

Before operating



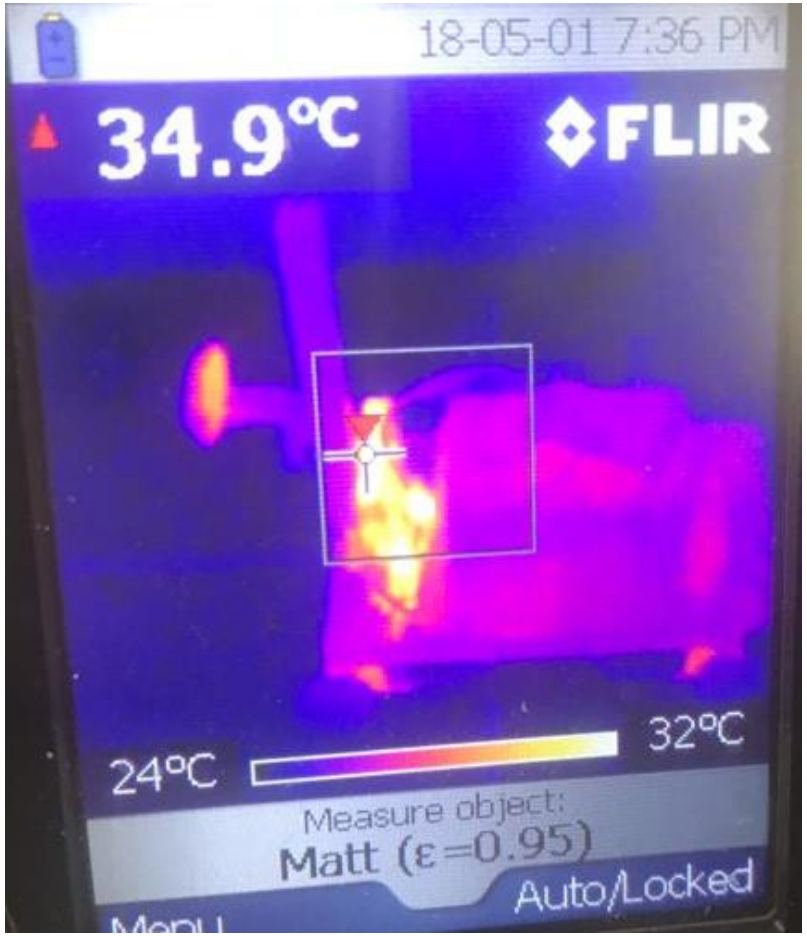
After operating (~10min)

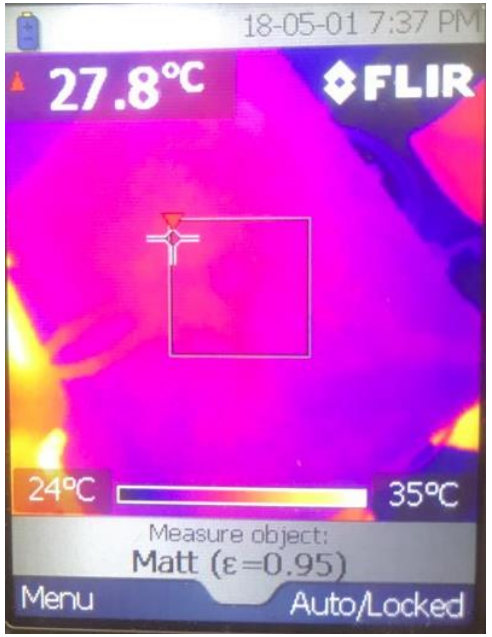


myRIO

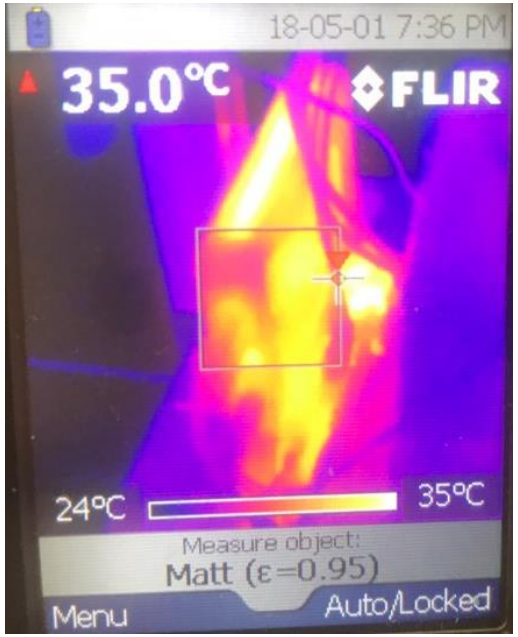
ABOUT HEAT RELEASE

- Using thermal camera after operating (~10min)

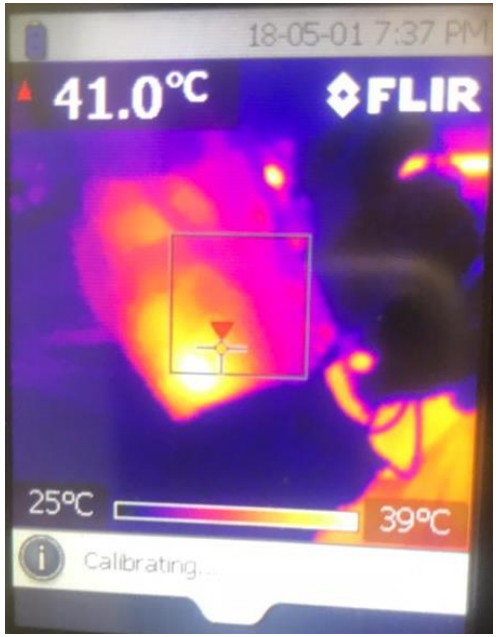




Battery
(wire connection part)



myRIO



Dynamixel

Thank you for your attention