NUNU

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Team Members: 김기정, 김병학, 김종원, 부준요, 정인철, 조민재, 한솔


김기정


김병학


김종원

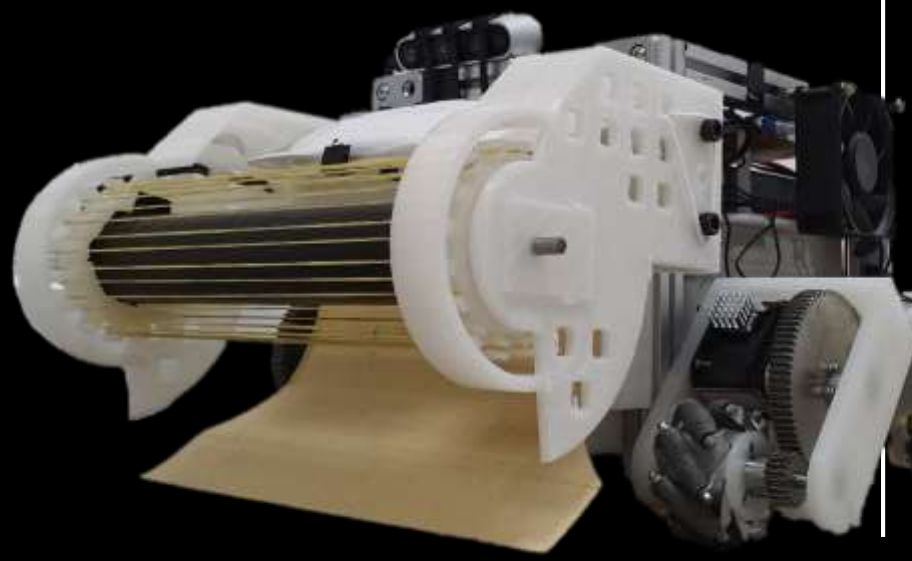

부준요


정인철


조민재


한솔

NUNU



SPEC

Hardware

- 380 X 480 X 240 [mm]
- 8 [kg]
- 4:1 Gear Ratio
- Suspension
- Depth Camera
- 0 Step Pick-up

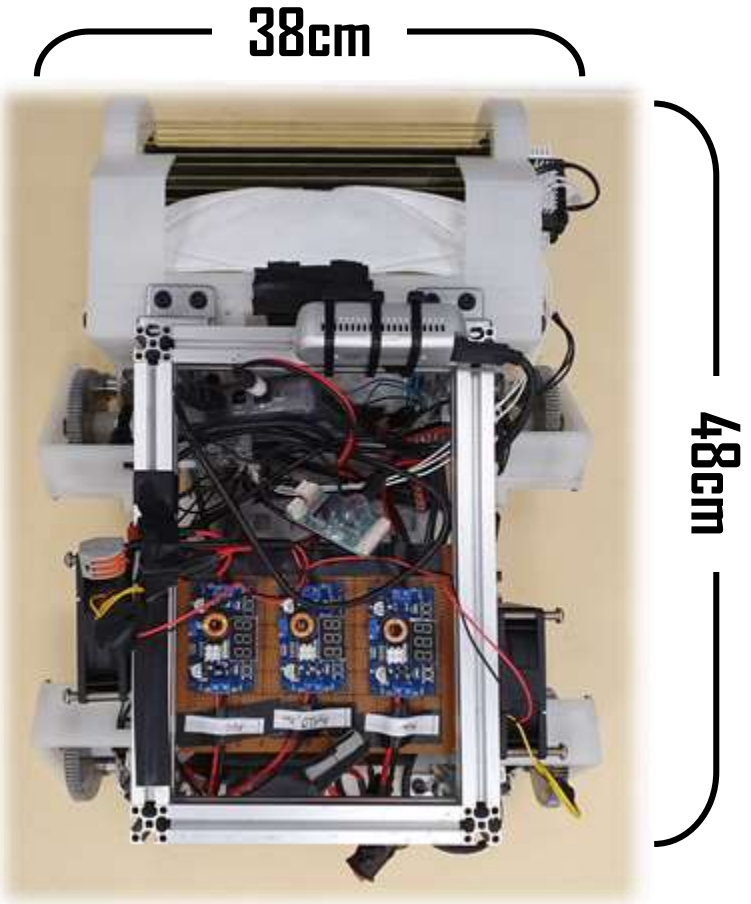
Software

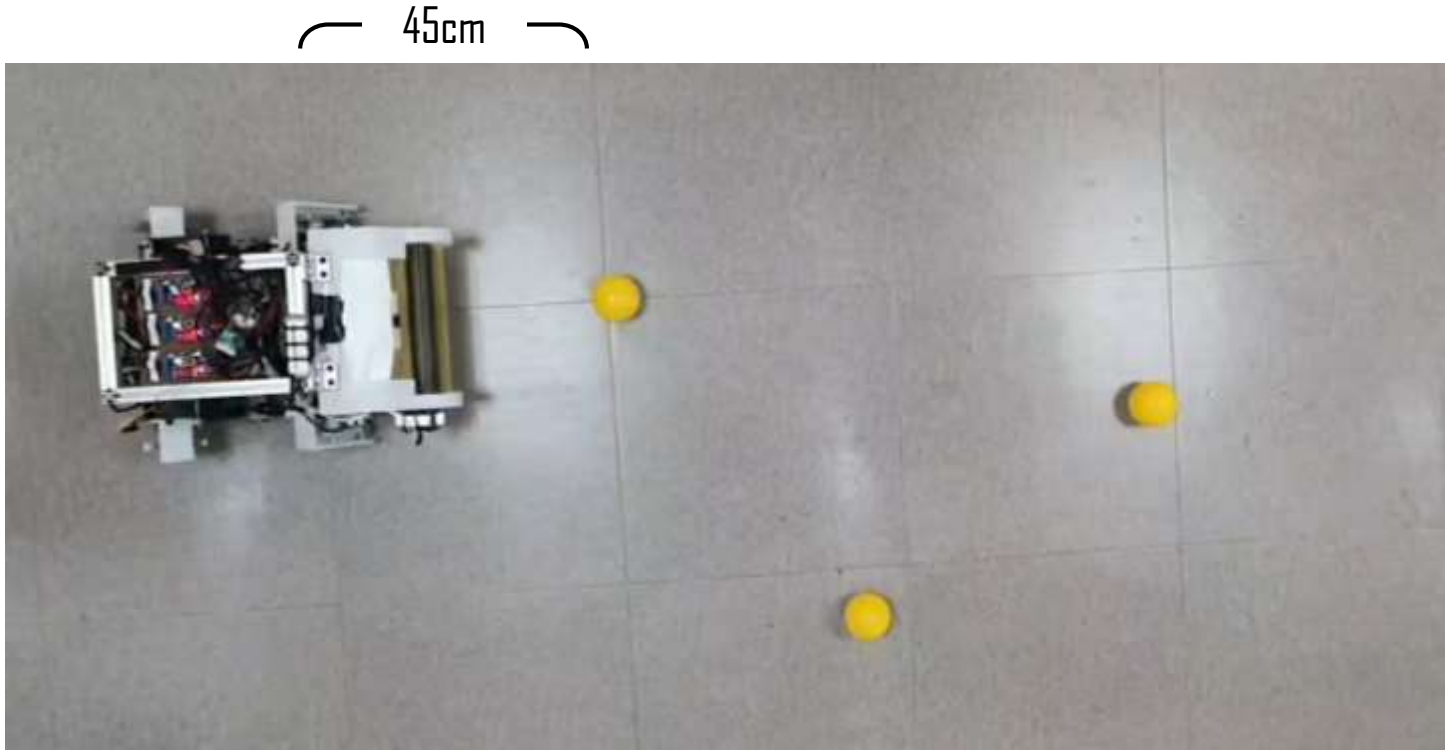
- Planning
- Ball Detection
- Perfect Align

1 SolidWorks

Body / Actuation / Pick Up & Drop Off / Heat Management

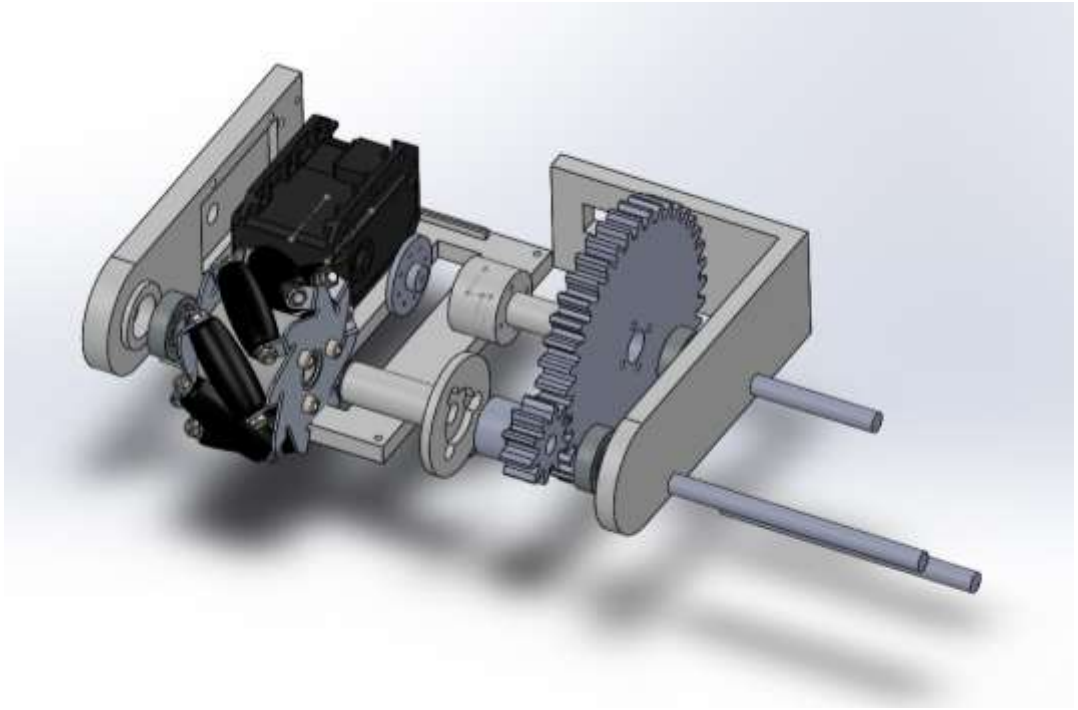
01 Small Size Body unnecessary avoidance ↓ / red ball collision ↓



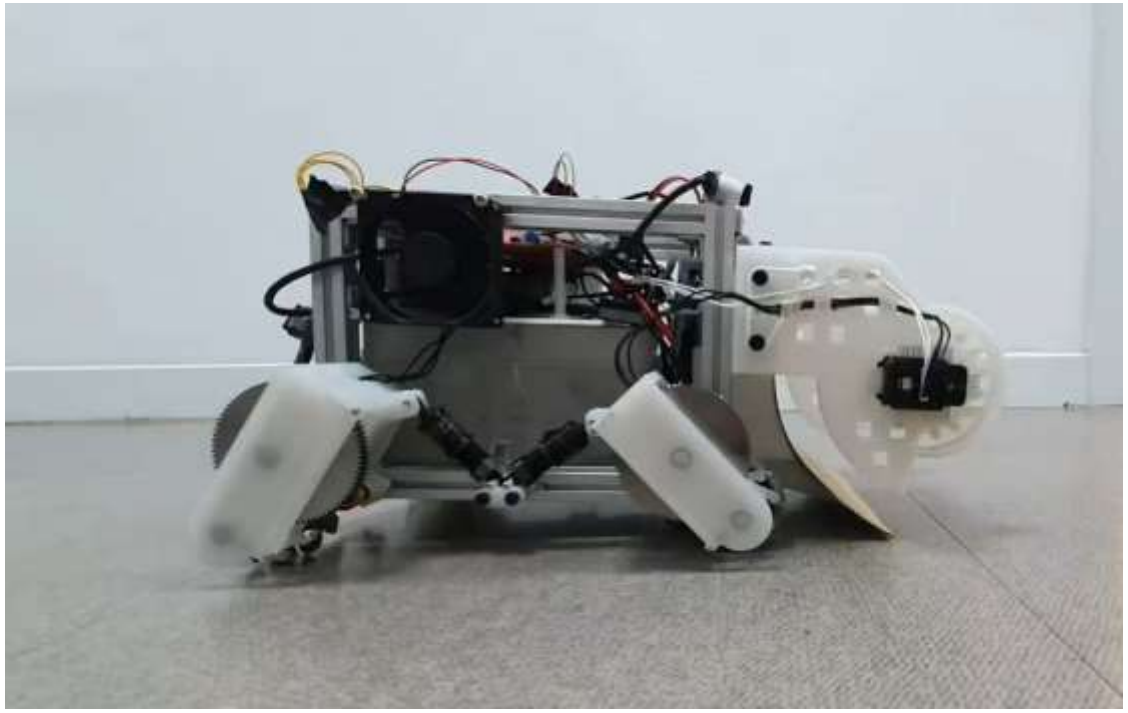


02 Actuation Module

4 point ground contact during whole drive / shock absorption



[Gear Box exploded view]

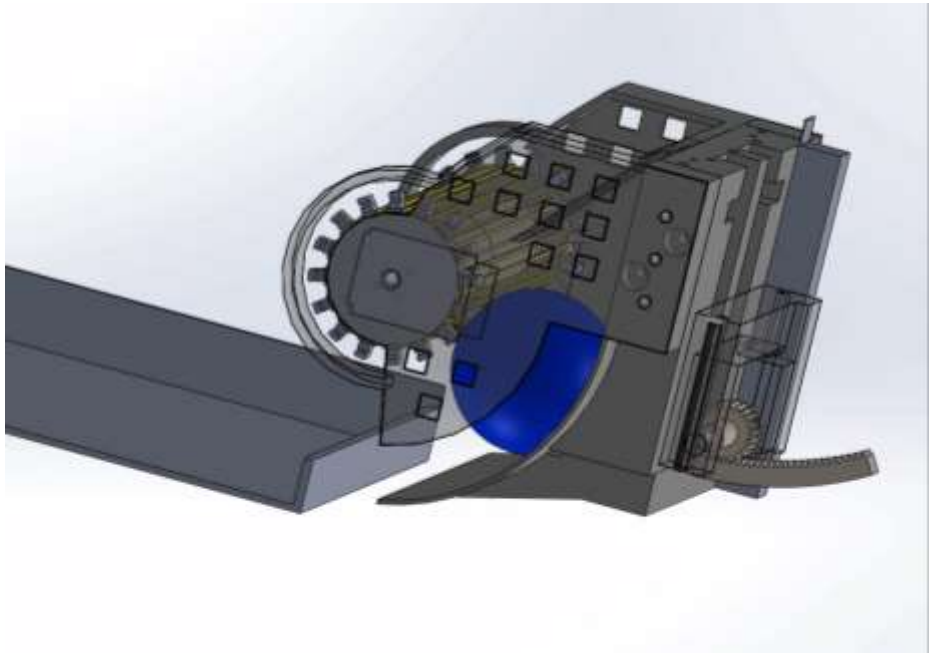


03 Pick Up Module continuous picking up motion

04 Drop Off Module

stable release motion by pushing up pick up & drop off module

Previous
Drop off module
(bumper motion)

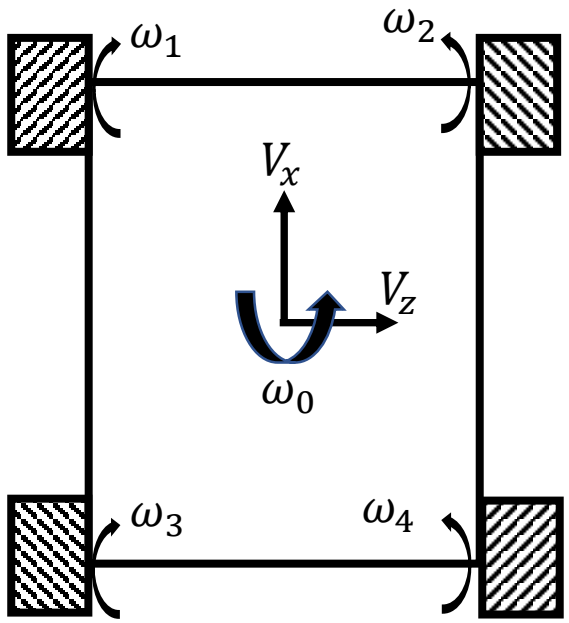


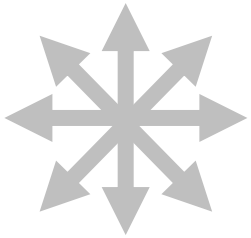
Present
Drop off module
(pushing up the module)

2 Motor Control

Over all circuit / movement / control with Xbox

01 Motor Control completeness





make whole directional motion

to find best motion(vector) for each situation

using the relationship between motor rotation and whole system vector

rotation of motor

vector of car

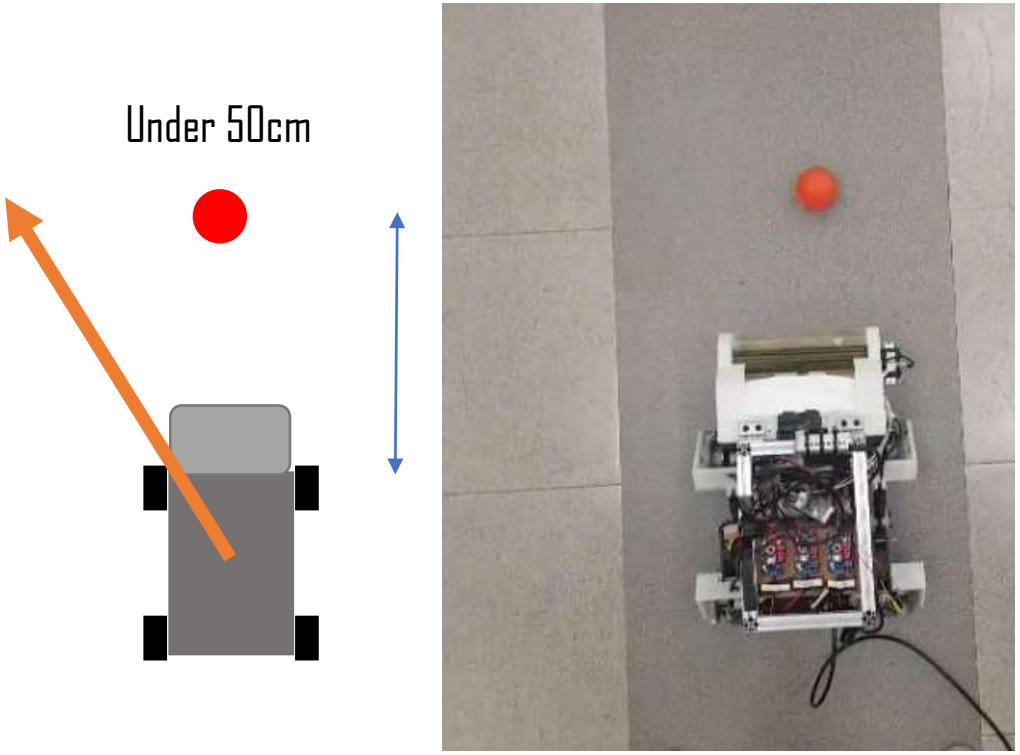
$$R\begin{bmatrix}\omega_1\\ \omega_2\\ \omega_3\\ \omega_4\end{bmatrix}=\begin{bmatrix}1 & 1 & -(l+L)\\ 1 & -1 & (l+L)\\ 1 & -1 & -(l+L)\\ 1 & 1 & (l+L)\end{bmatrix}\begin{bmatrix}V_x\\ V_z\\ \omega_0\end{bmatrix}$$

02 Motor Control motion for avoiding red ball

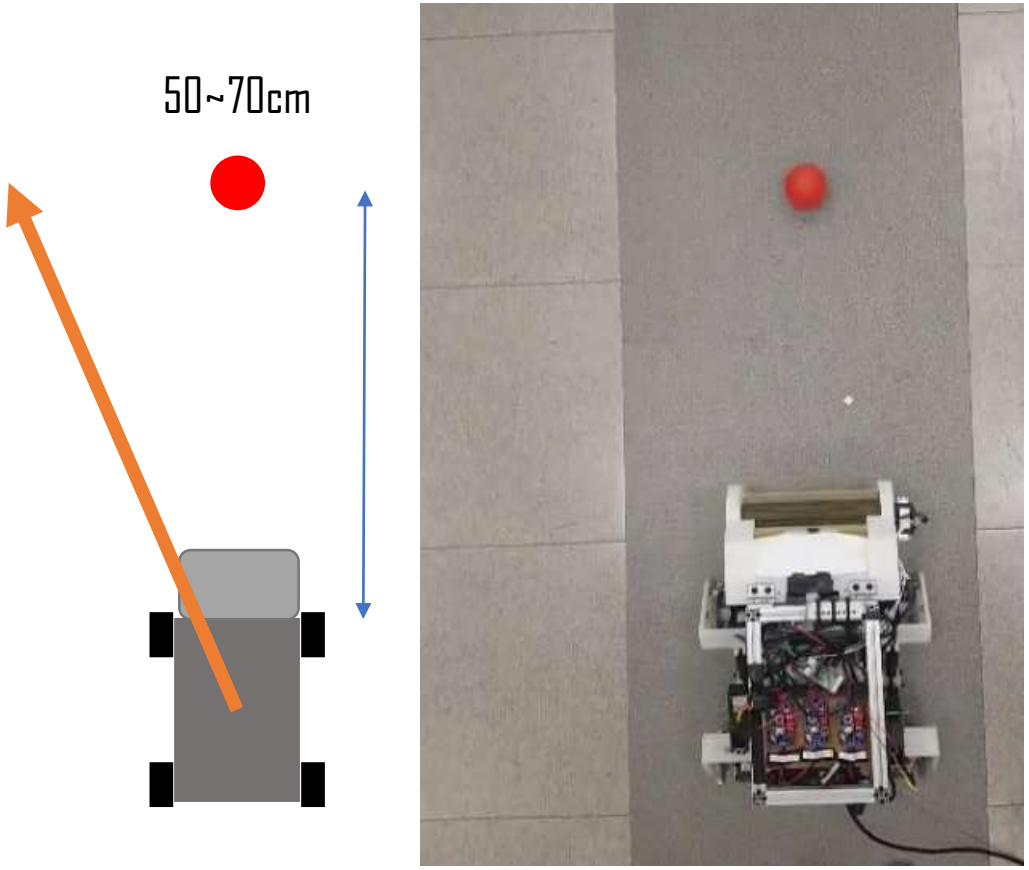
For better red ball avoidance,

Choose the velocity ratio of V_x , V_y depending on the distance range

Under 50cm



50~70cm

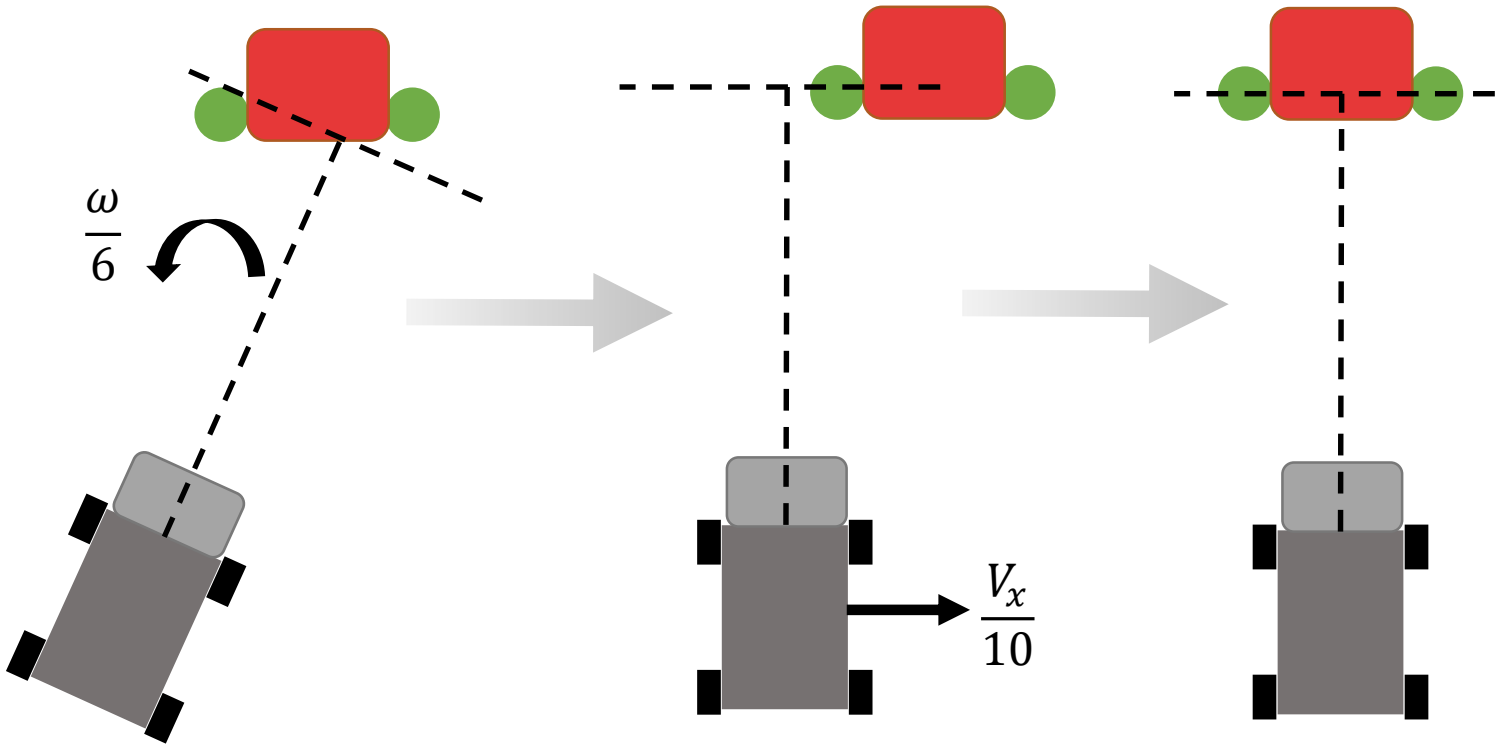


03 Motor Control motion for aligning the destination

for exact aligning, although latency between cam, ROS, labview, motor >> high speed not good

general rotation vel * 1/6 – perpendicular to wall

general aside moving vel * 1/10 – to the center of green balls



3 Open CV

Camera / Ball Detecting / Sorting

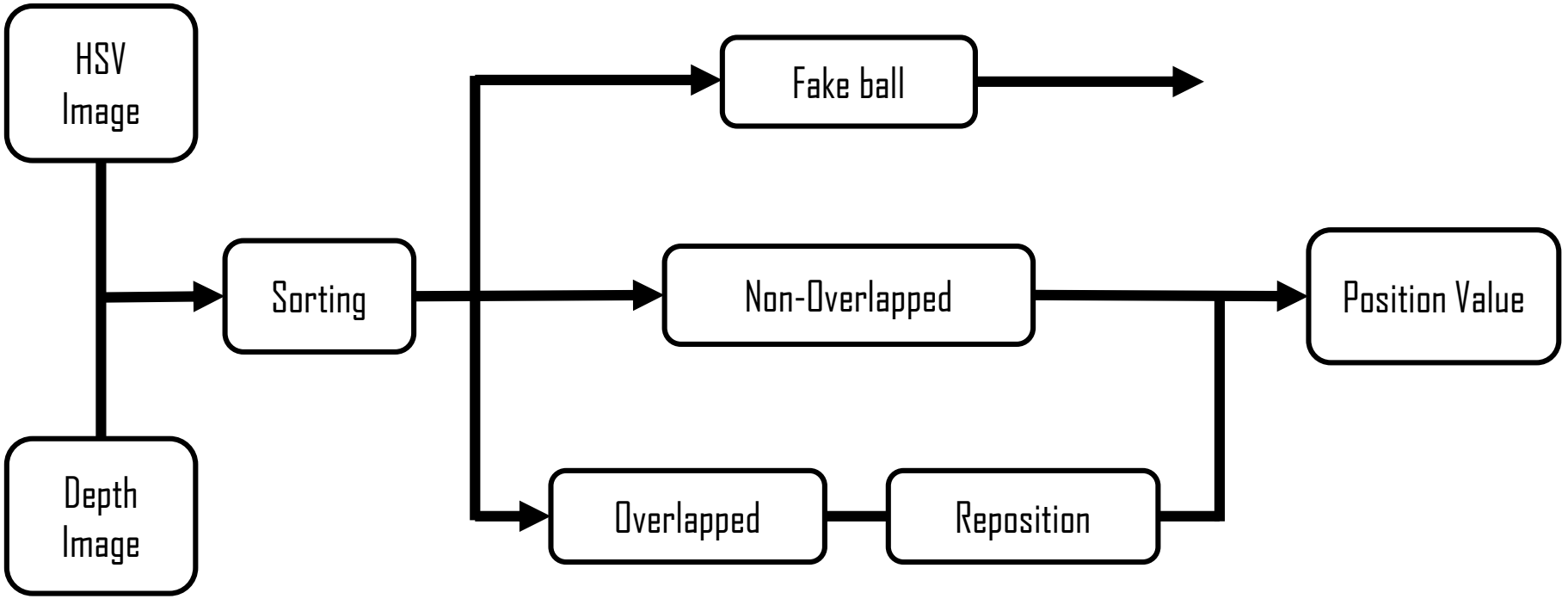
01 Real Sense Camera stabl

Real sense Camera for wide view

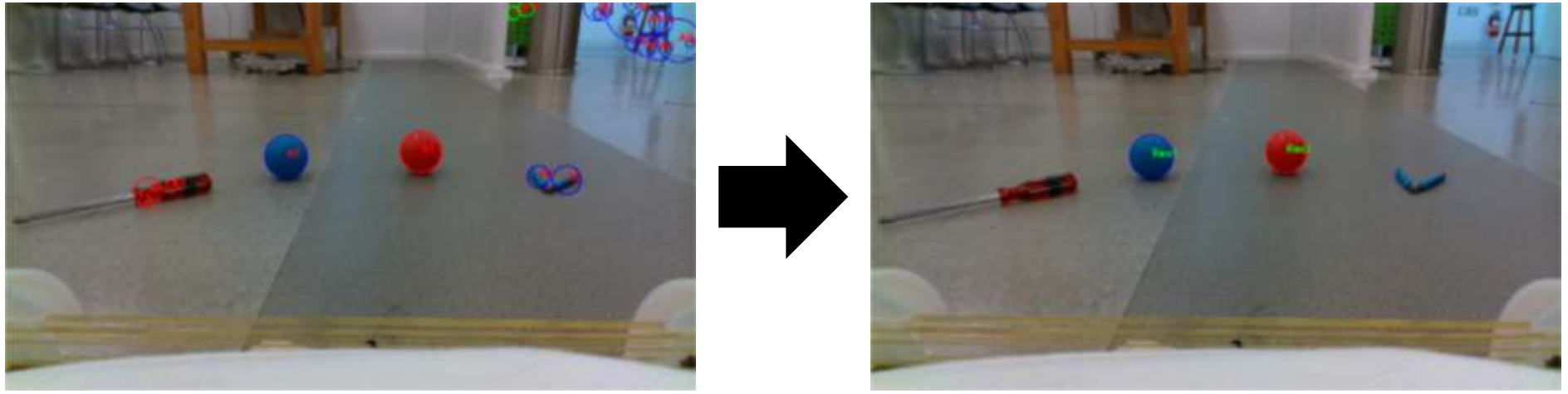
Logitech Webcam

Real sense RGBD cam

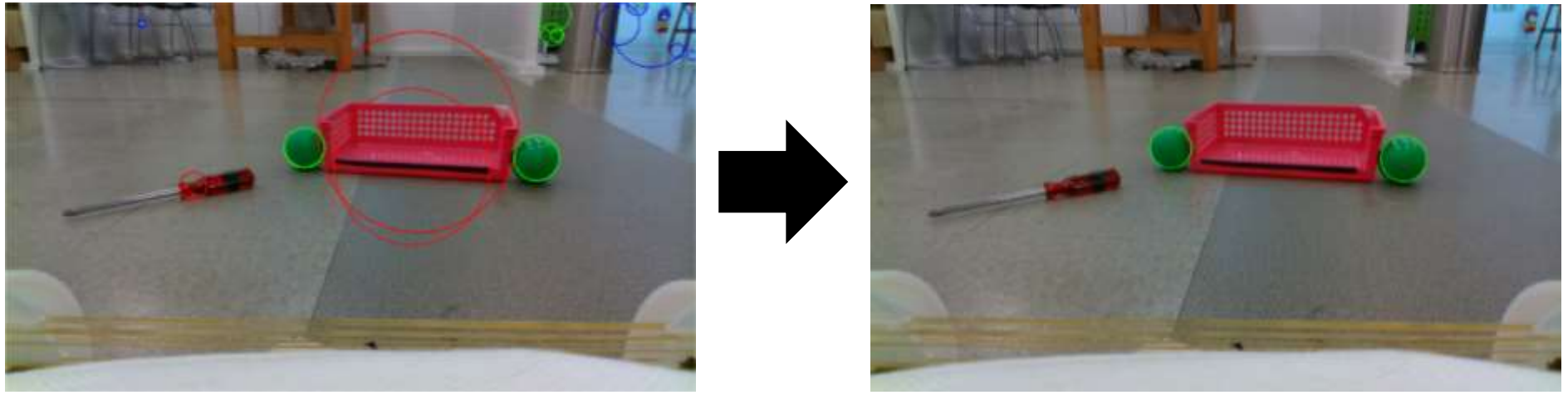
02 Image Procession for Ball Detecting



03 Sorting Method erase fake ball for clear movement

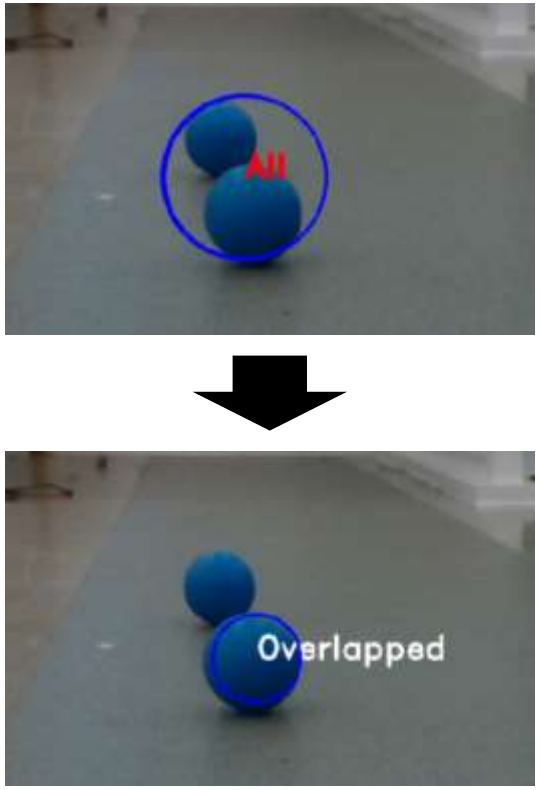


(Depth based distance ≠ HSV based distance) → fake



03 Sorting Method handle overlapped ball for path planning

Different color



Same color

4 ROS

Path Planning / Pick Up / Drop Off

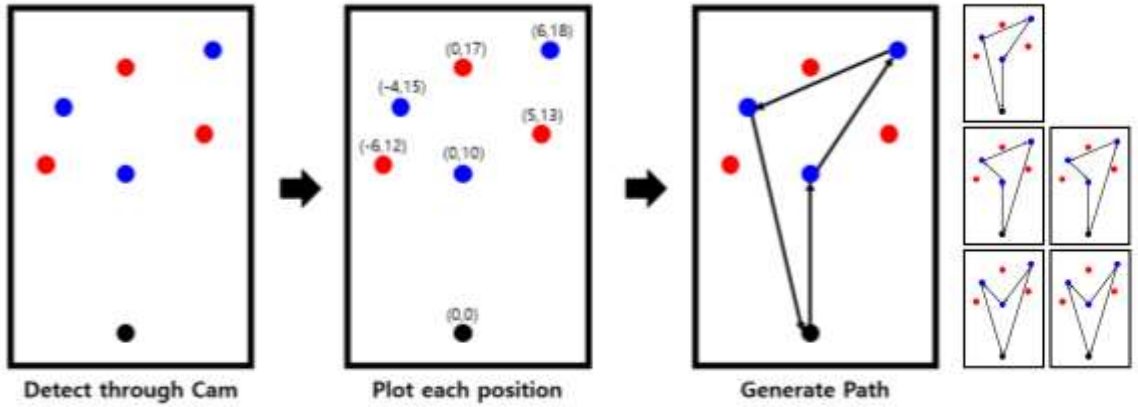
01 Path Planning

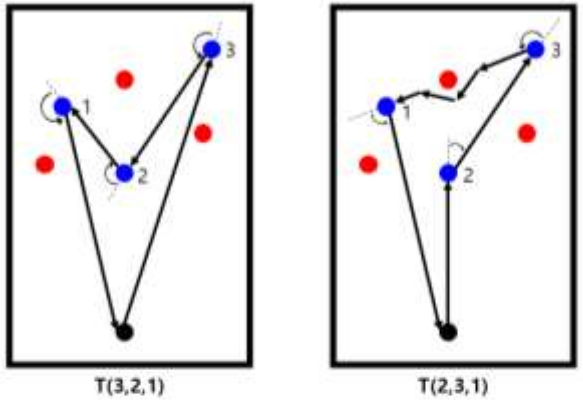
Why? : Path planning can reduce time for searching balls. Also can have different stratagem based on weight value

Ball Coordinate	Pre-processing	Path Planning	Rough Angle
Raw data from ball_detect_node	Filter & average few frames for accuracy	Based on the ball_coor and weight value Calculate best order	Based on the collecting order, calculate rough angel rotation for fast detection and collection

blue_ball_num
red_ball_num
 	
b_ball_X[n]
b_ball_Y[n]
 	
r_ball_X[n]
r_ball_Y[n]
	b_ball_x[3]
	b_ball_y[3]
	
	r_ball_x[3]
	r_ball_y[3]
		Ex)
		b1 = 1;
		b2 = 0;
		b3 = 2;
			Ex)
			Angle1 = 11;
			Angle2 = 65;
			...

01 Path Planning stabl





T(3, 2, 1)

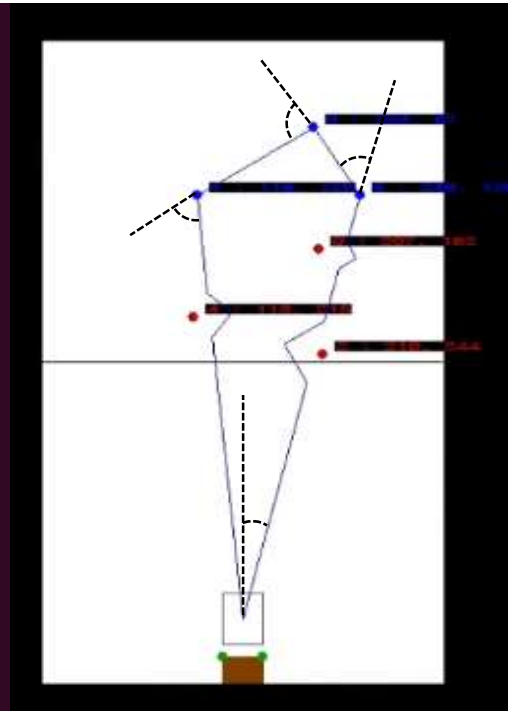
Type	Time[s]
Straight	a
Rotation	b
Diagonal	c
Conversion1	d
...	...

T(2, 3, 1)

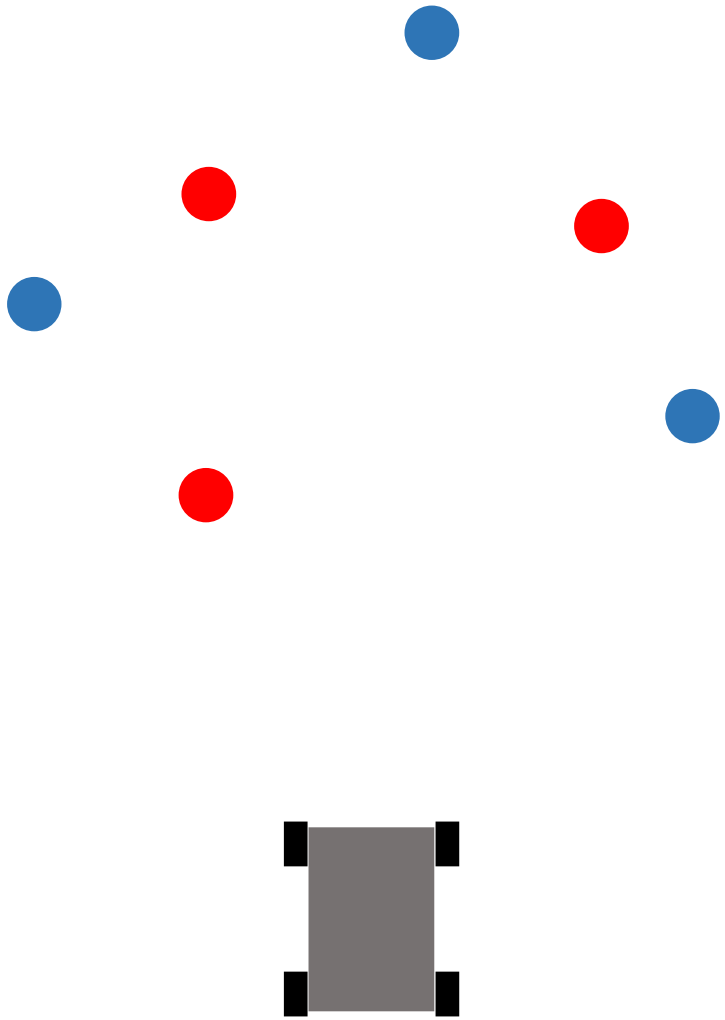
Type	Time[s]
Straight	A
Rotation	B
Diagonal	C
Conversion1	D
...	...

- T(3,2,1) = a+b+c+d+...
- T(2,3,1) = A+B+C+D+...
- Compare T(1,2,3)−T(3,2,1)
- Pick smallest T for the final path

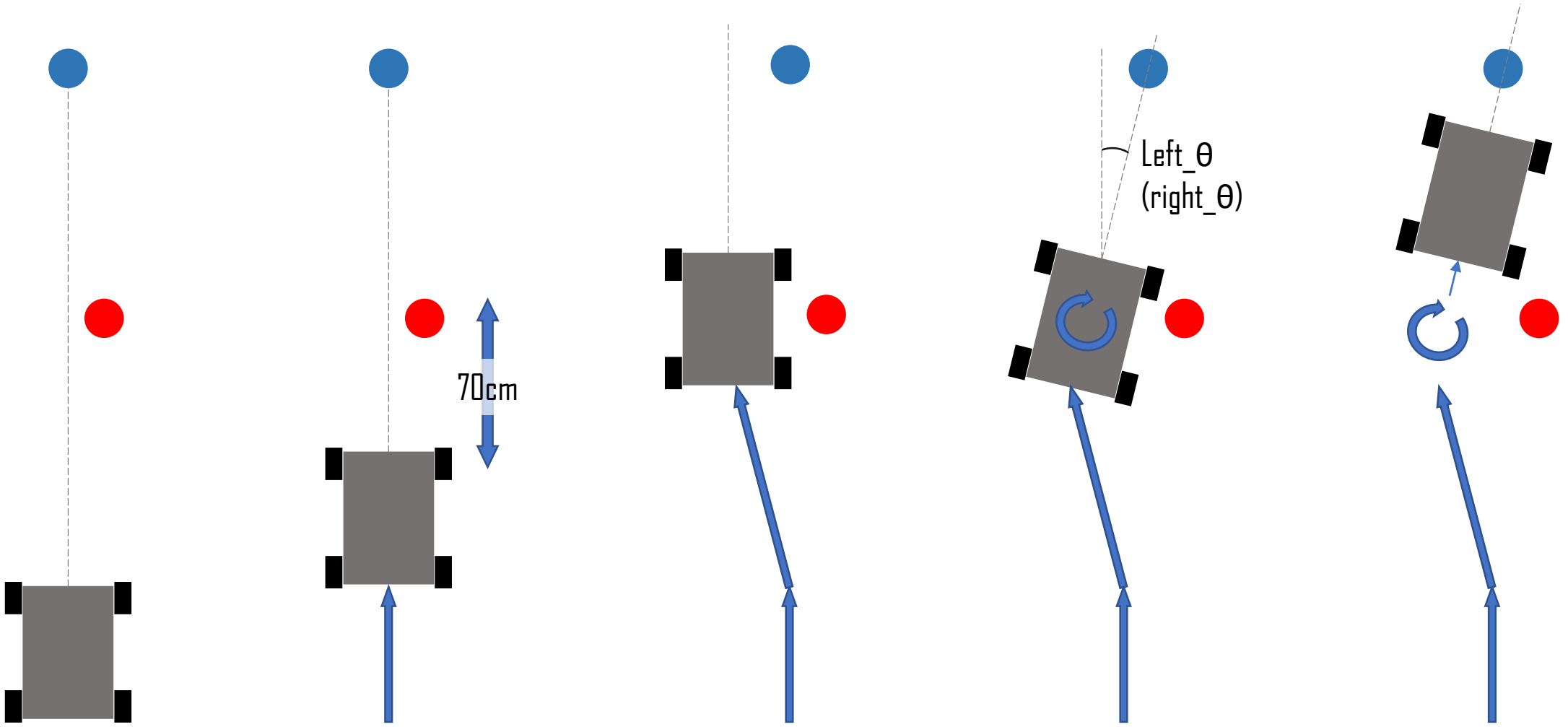
```
ball position (x, y) [cm]
blue 0 = ( -60, 380 )
blue 1 = ( 5, 290 )
blue 2 = ( 80, 350 )
red  0 = ( -75, 280 )
red  1 = ( 0, 370 )
red  2 = ( 75, 280 )

tcost per path
0, 1, 2 : t = 218.328
0, 2, 1 : t = 200.914
1, 0, 2 : t = 199.806
1, 2, 0 : t = 200.914
2, 0, 1 : t = 199.806
2, 1, 0 : t = 218.328

best path
2(80, 350) => 0(-60, 380) => 1(5, 290)

angle1 : 12.875
angle2 : 90.7802
angle3 : 137.932
angle4 : 36.8254
angle5 : 0.98776
```



01 Path Planning result



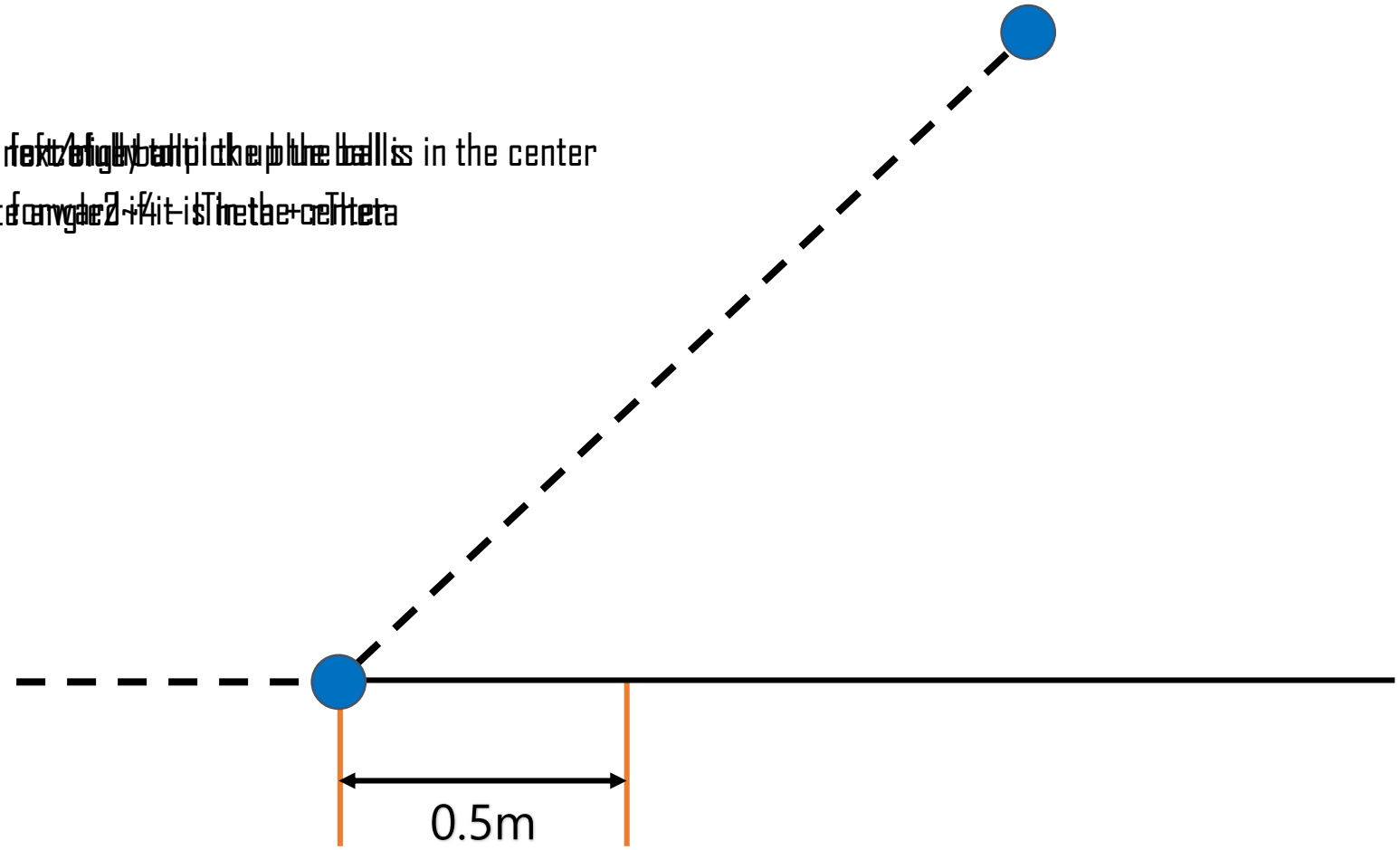
02 Pick Up Blue Balls

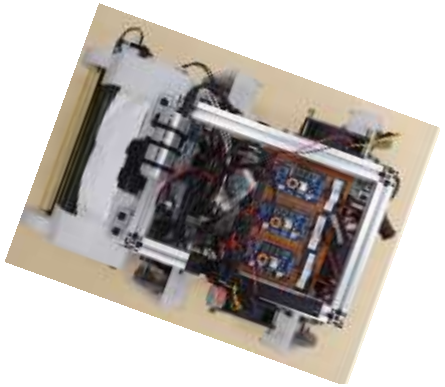


03 Pick Up Blue Balls

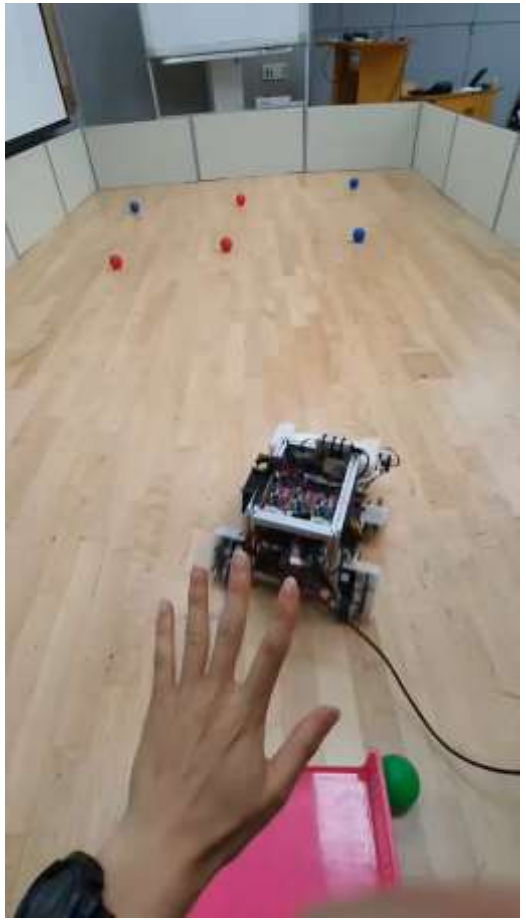
Step2

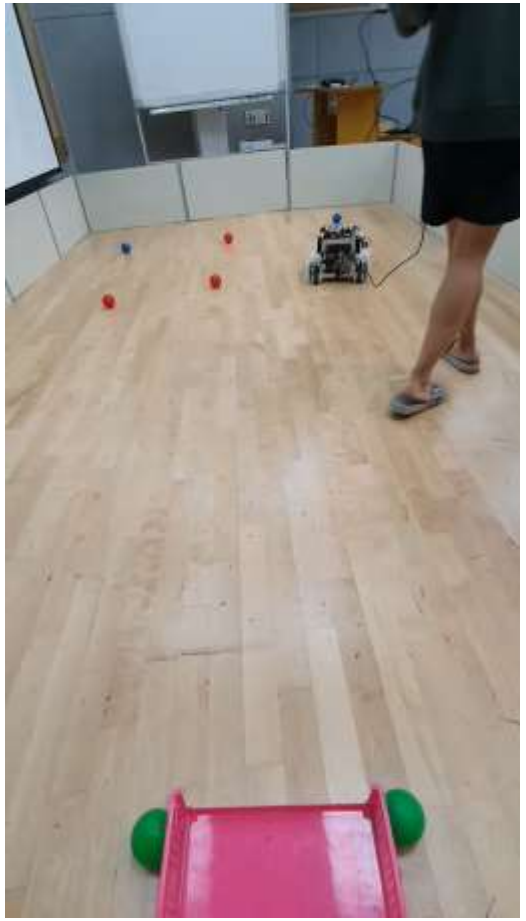
- Move left/right until the blue ball is in the center
- Move forward if it is the center





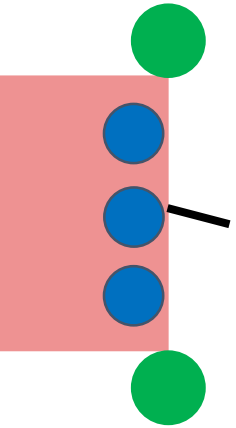
3 Different videos of Pick Up Motion

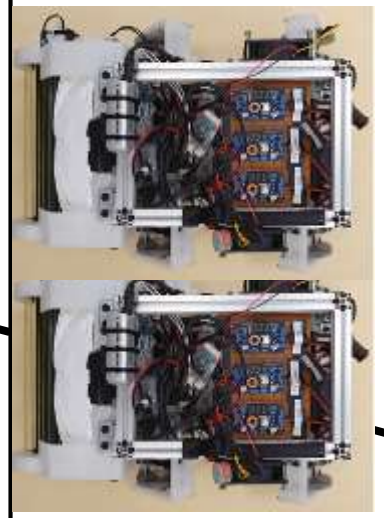




04 Drop Off Blue Balls

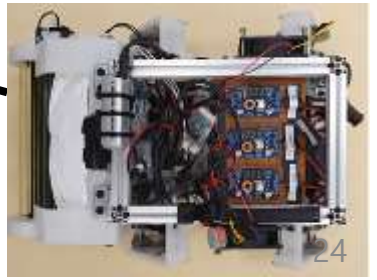
<0.6m | 0.6m~1.5m | >1.5m



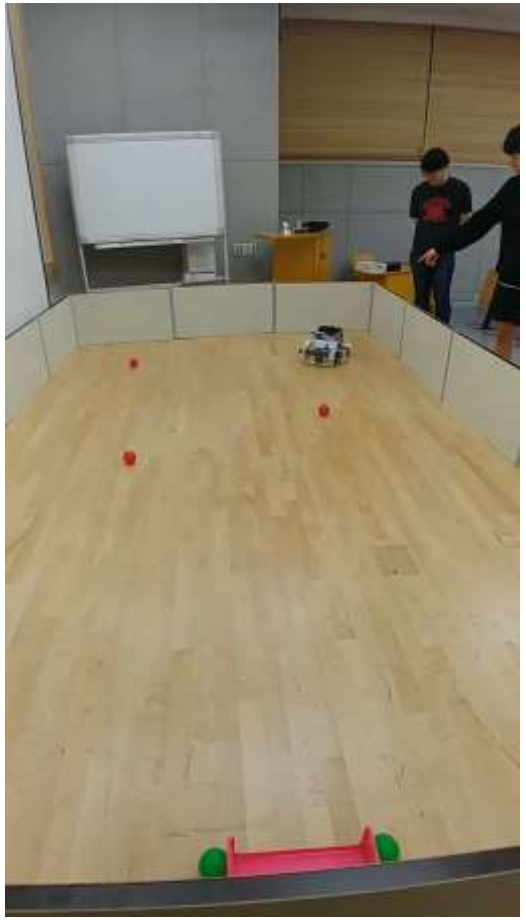


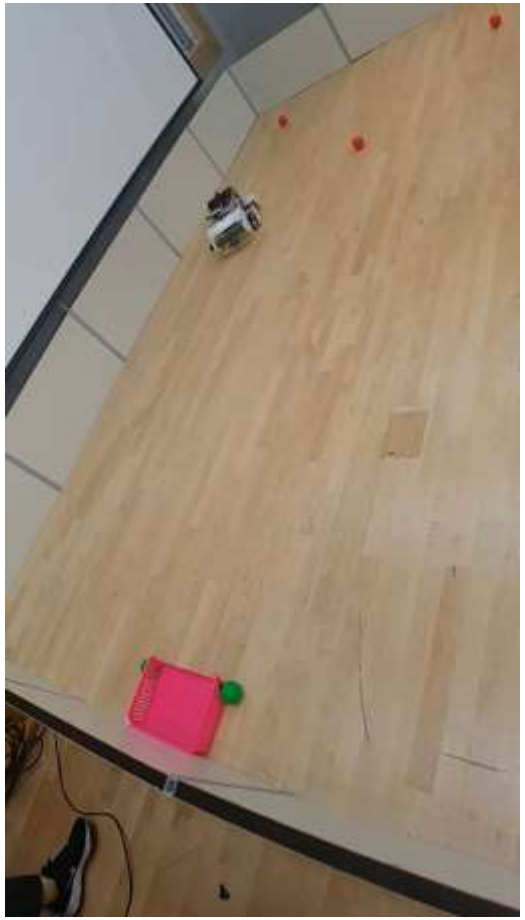
Step 3

- Move forward until the distance is 0.6m
- Move left/right until the basket is in the center
- Rotate until the basket is parallel to the wall



3 Different videos of Drop Off Motion





Thank You for your attention