Capstone Design 2
Final Design Review

Team Theseus

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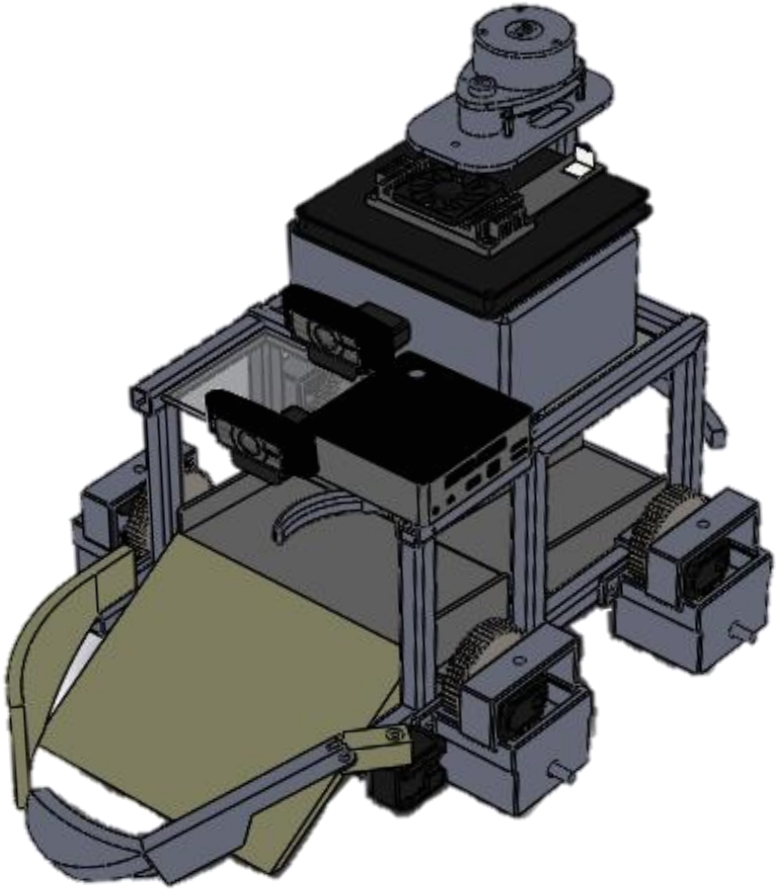
손지혁 조현근 장신원

Outline


System Overview
Distinguishing Features
Engineering Design Issue
DQN involved Ball Collection

System Overview

System Overview



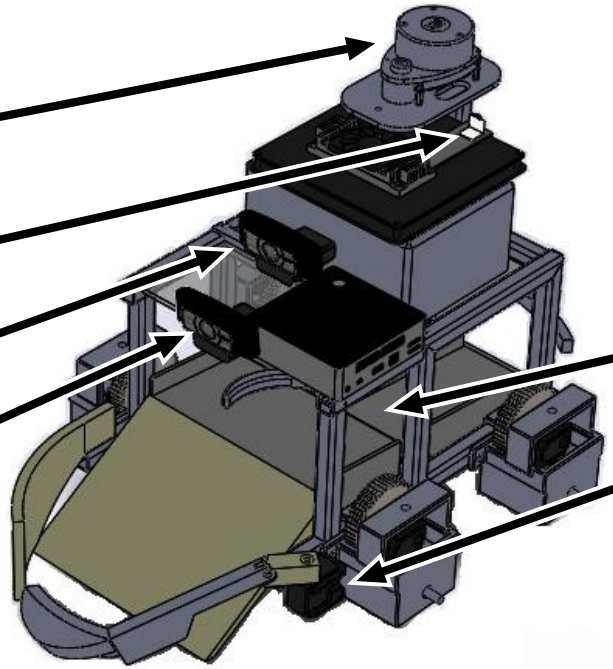
Size : 420mm* 600mm* 427mm

Weight : 8.3kg

System Overview

Sensor

- RPLidar
- Jetson camera
- main webcam
- sub webcam



Driving Unit

- 4 wheel motors
- 1 sort/release motor
- 1 collecting motor

System Overview

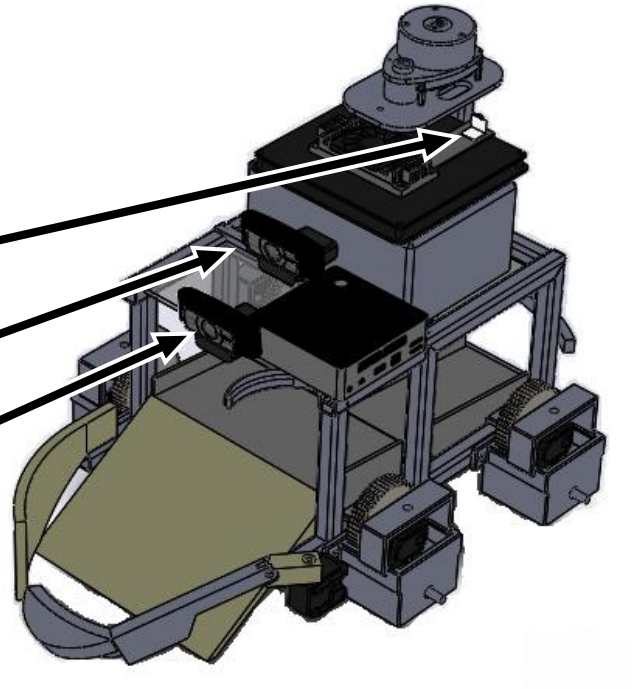
Sensor

RPLidar

Jetson camera

main webcam

sub webcam



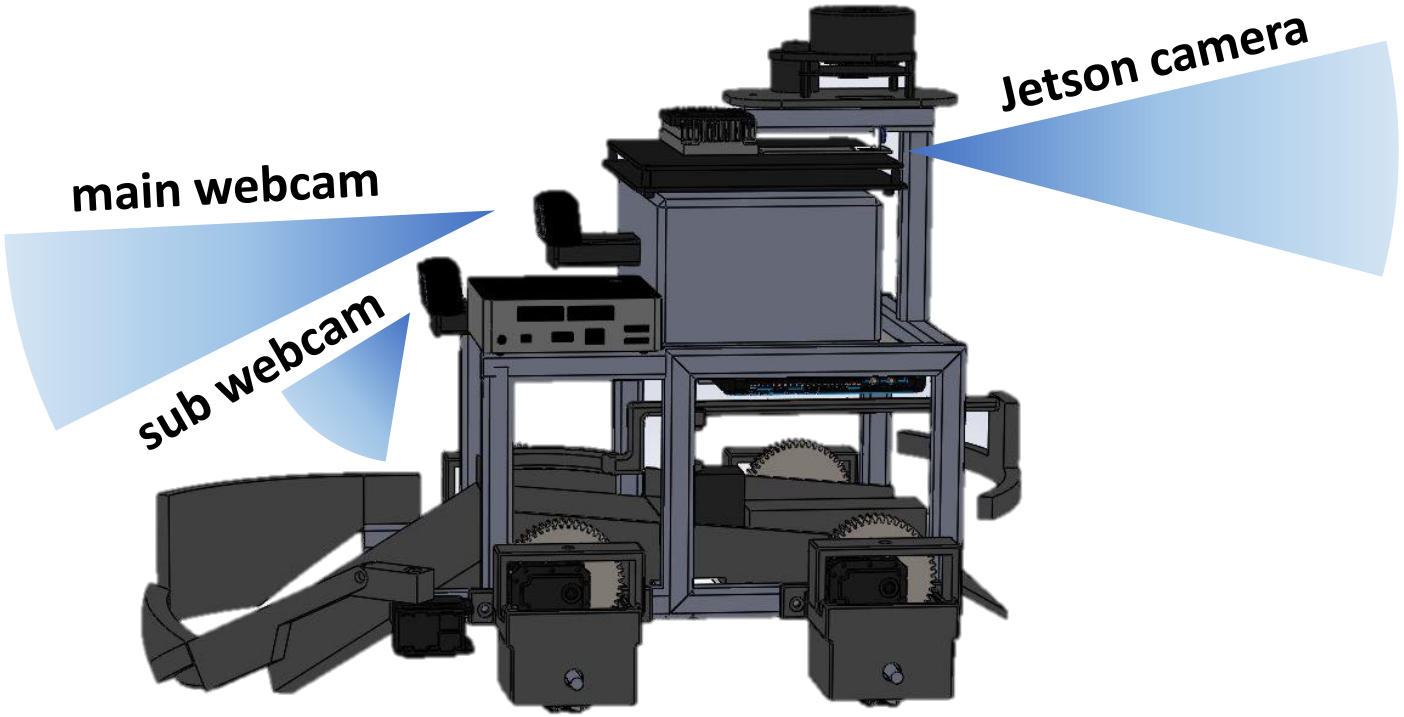
Driving Unit

4 wheel motors

1 sort/release motor

1 collecting motor

Why *three* cameras?

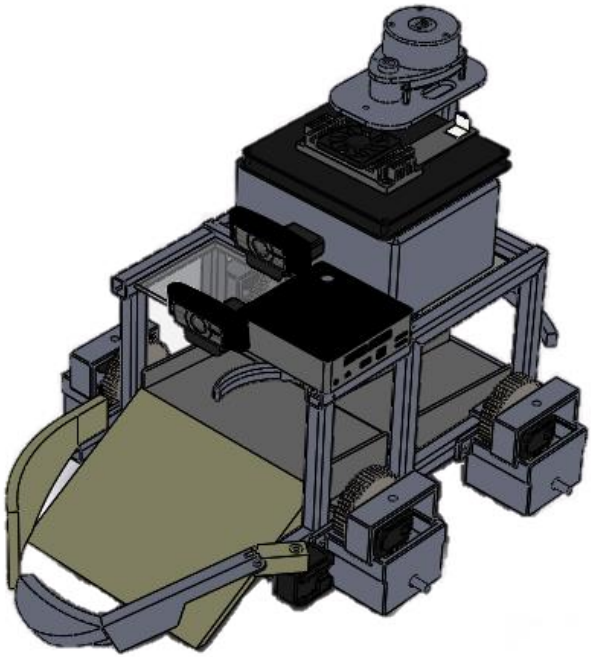


Distinguishing Features

Is your design reasonable engineering-wise?

Feature #1

Compact Size



Feature #2

Safety System

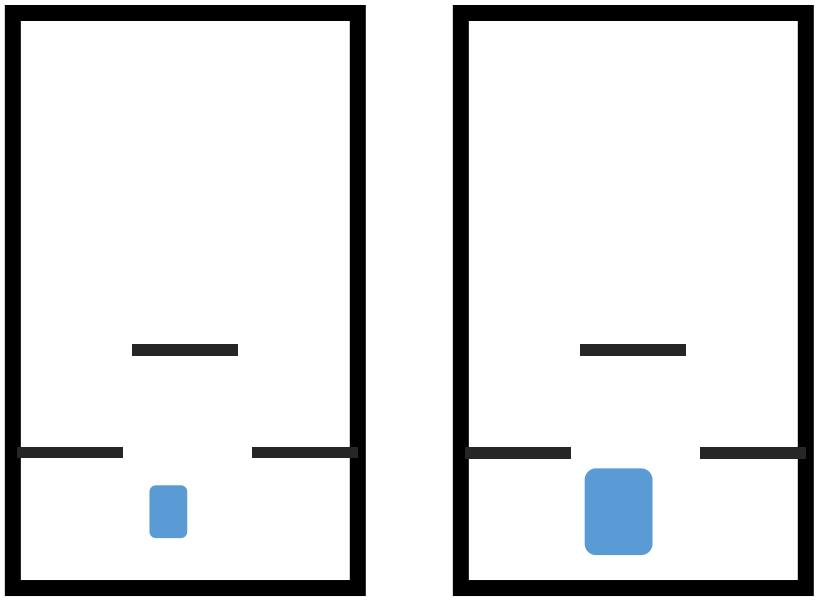
Collect

Park

Submit

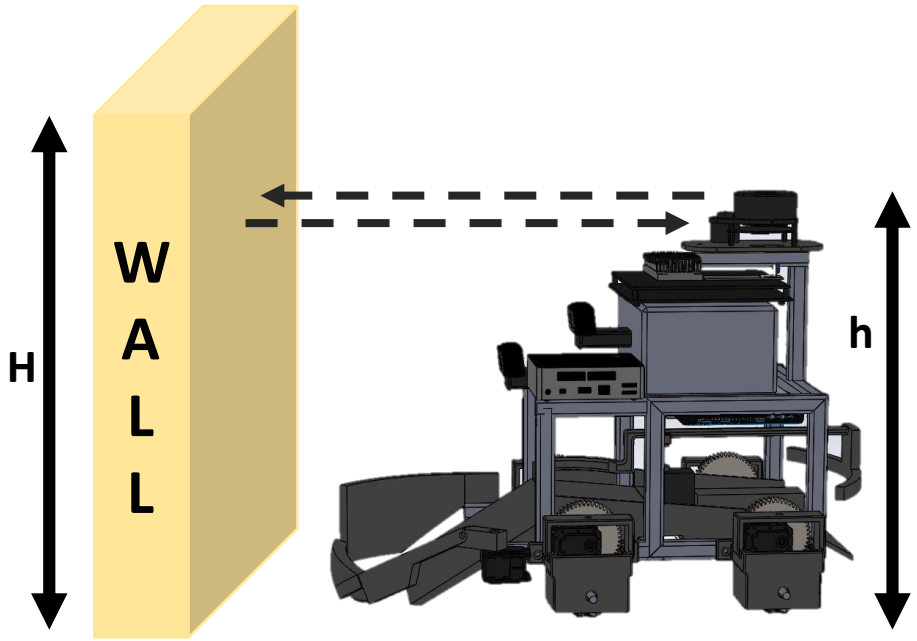
Feature #1

Compact Size



small vehicle

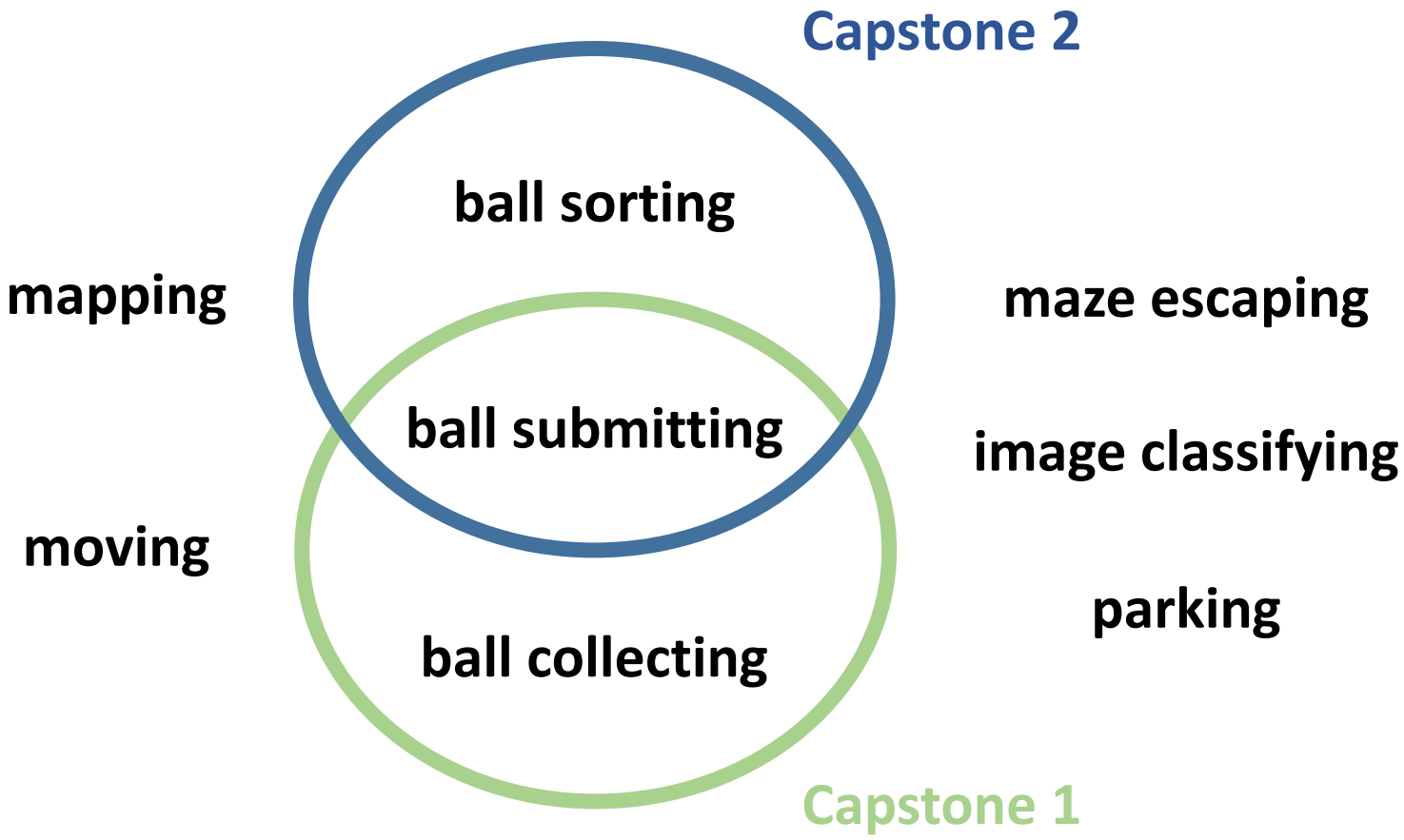
big vehicle



h < H

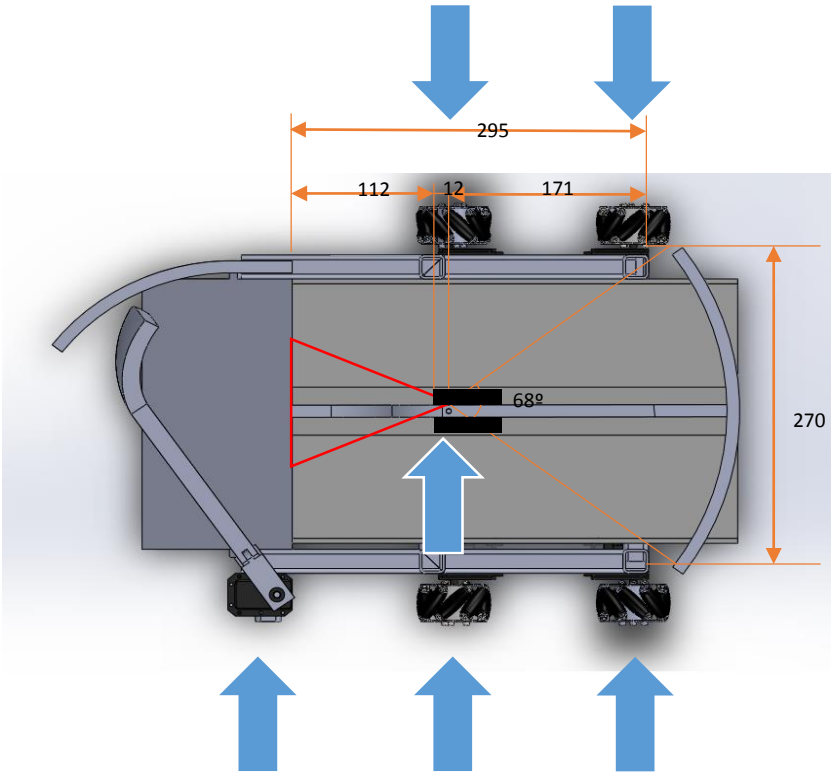
Feature #1

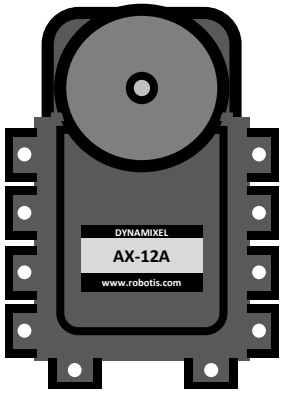
Compact Size



Feature #1

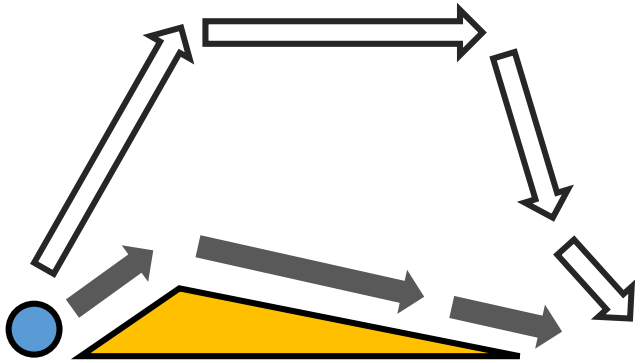
Compact Size





X 6

minimum number of motors

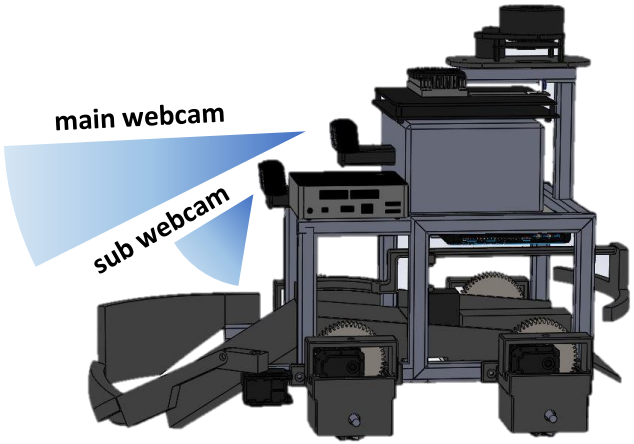


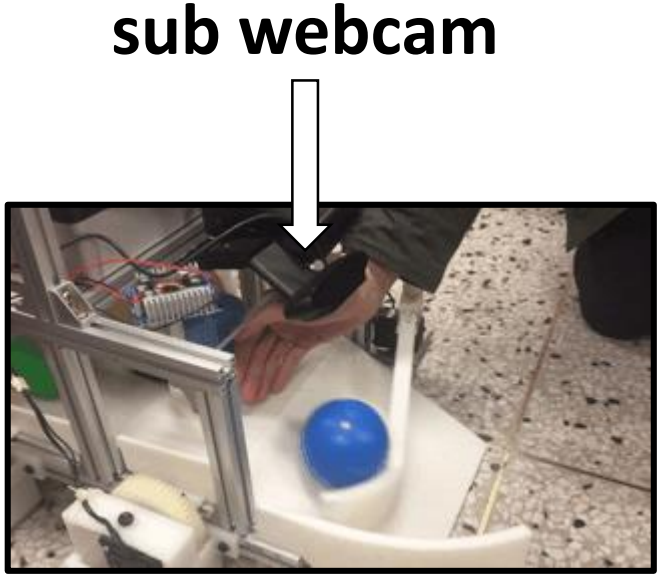
minimum path of ball

Feature #2

Safety System

Collect

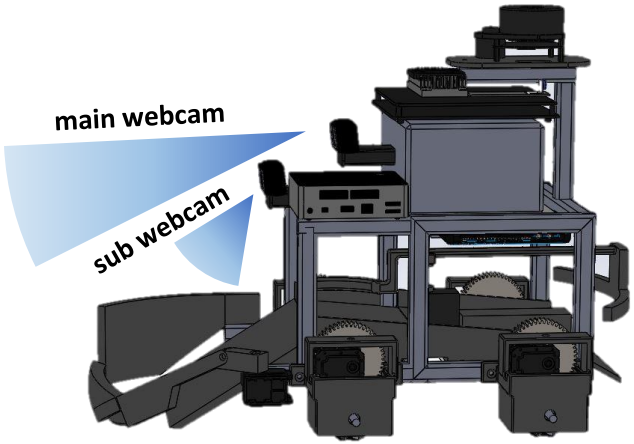


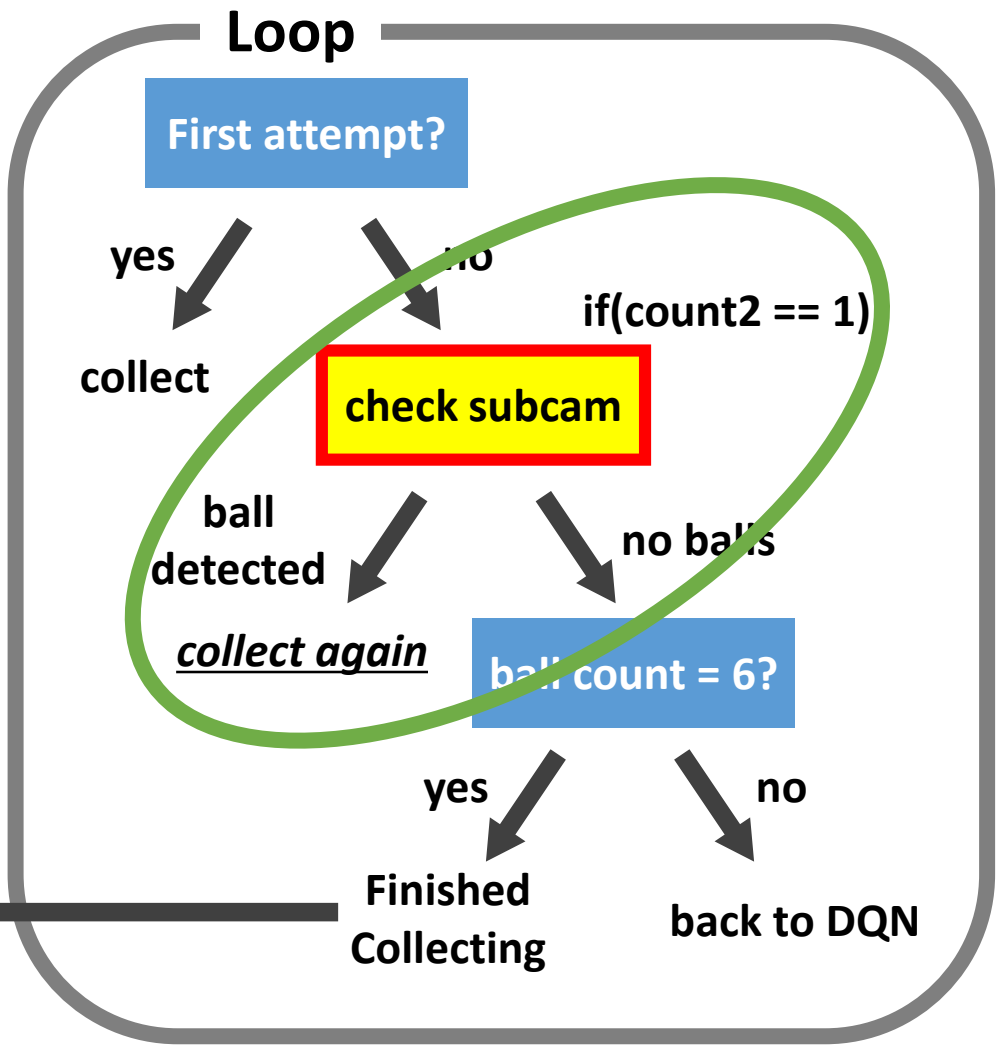


Feature #2

Safety System

Collect

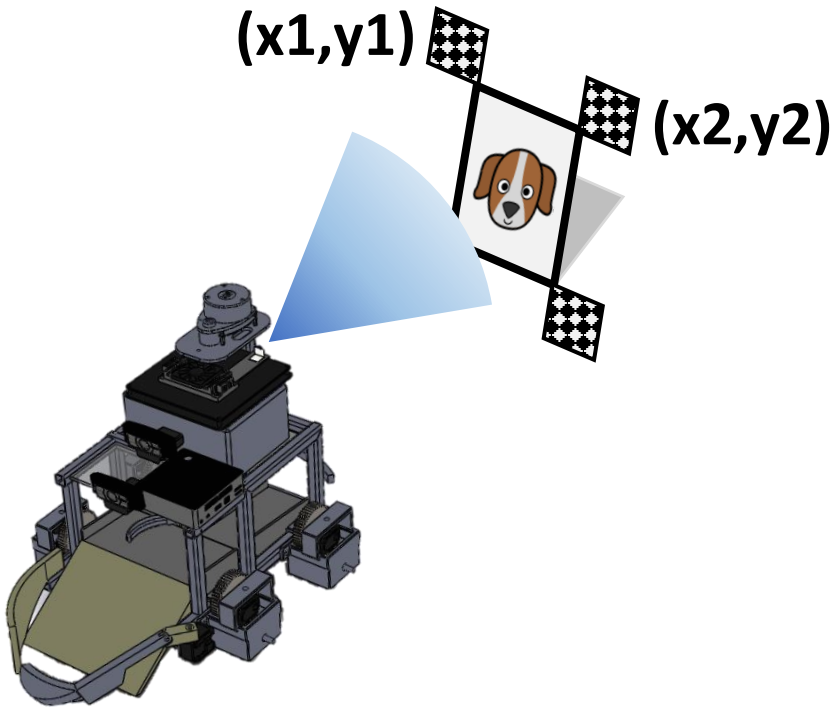




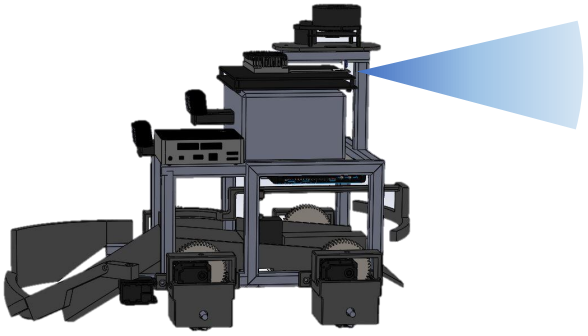
Feature #2

Safety System

Park



Do not start parking unless,

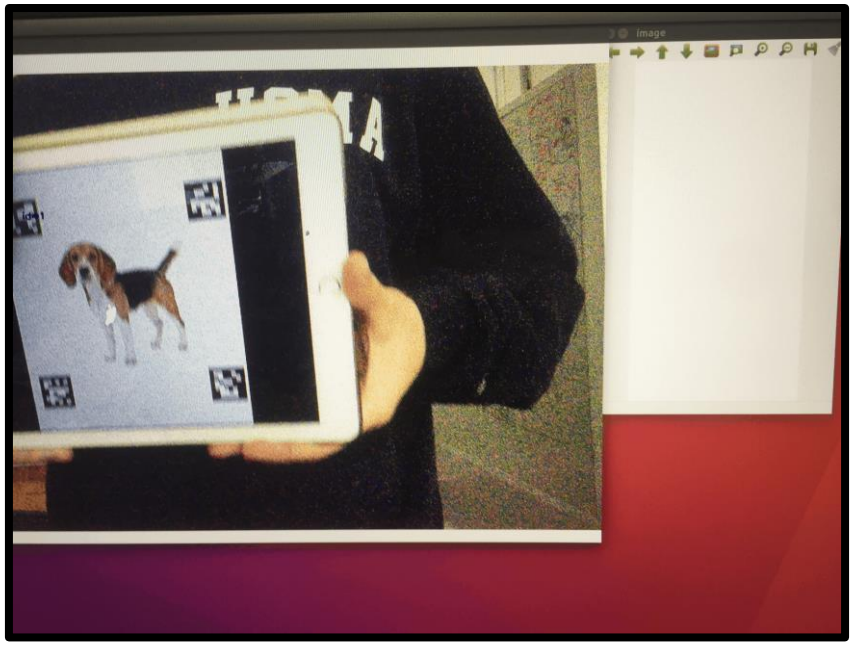


$$\text{“ } a < \frac{x_1 + x_2}{2} < b \text{ ”}$$

Feature #2

Safety System

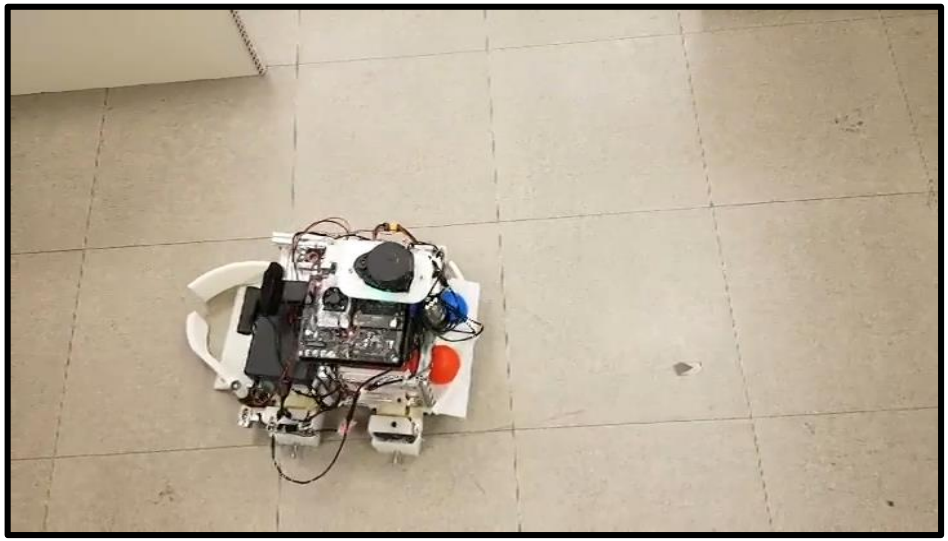
Park



Feature #2

Safety System

Park



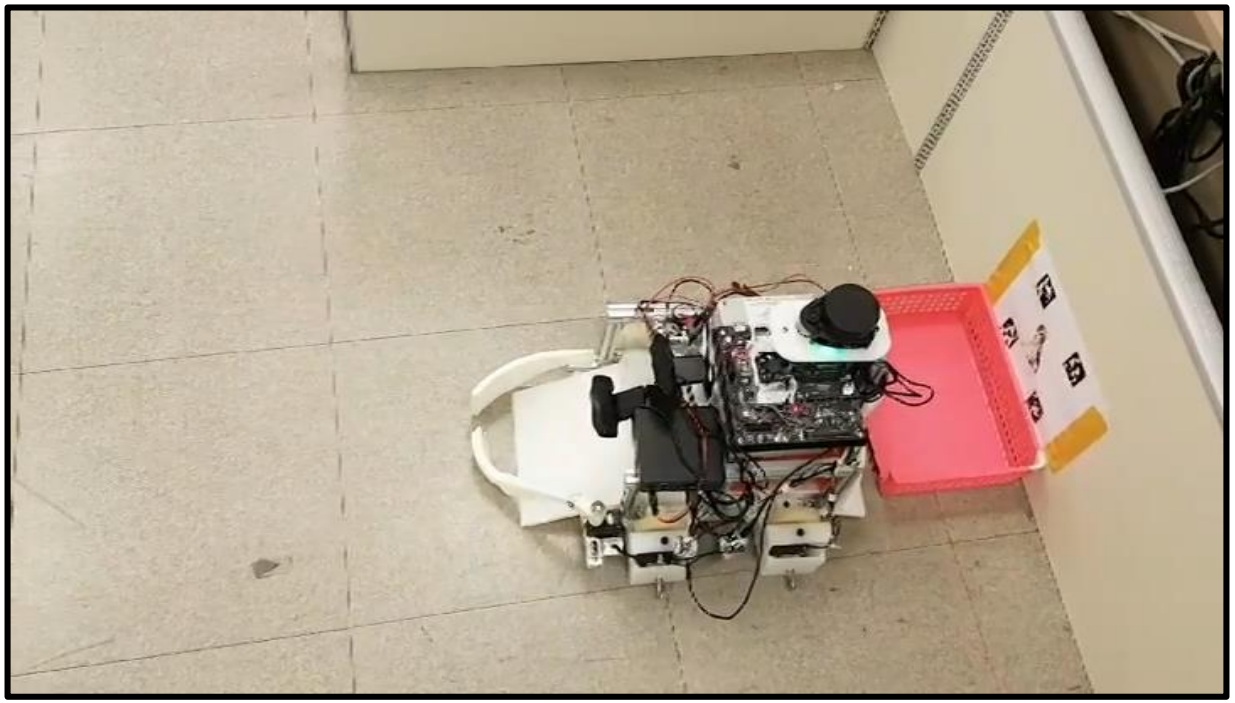
if marker positions have not changed for a while,

stop immediately to detect the markers again

Feature #2

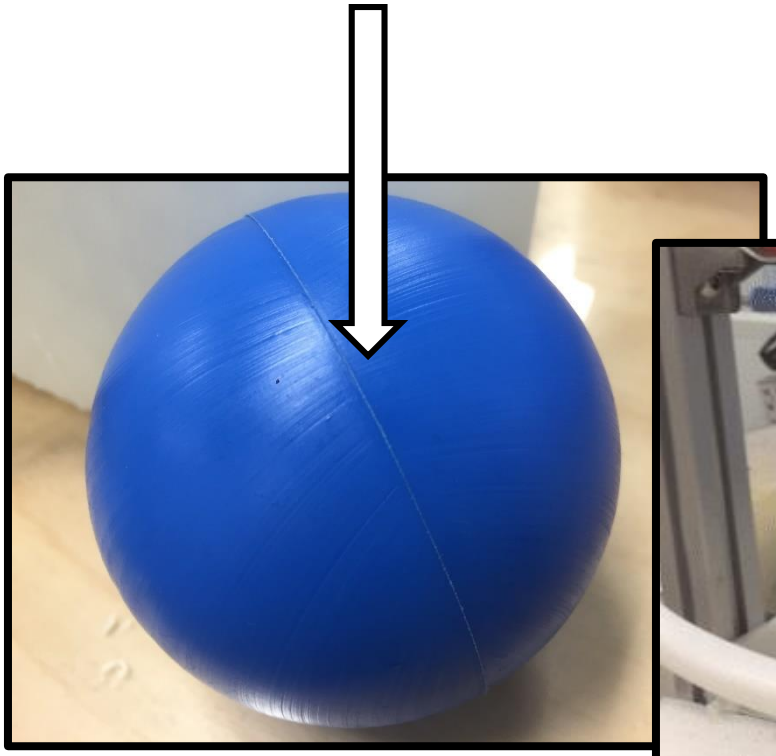
Safety System

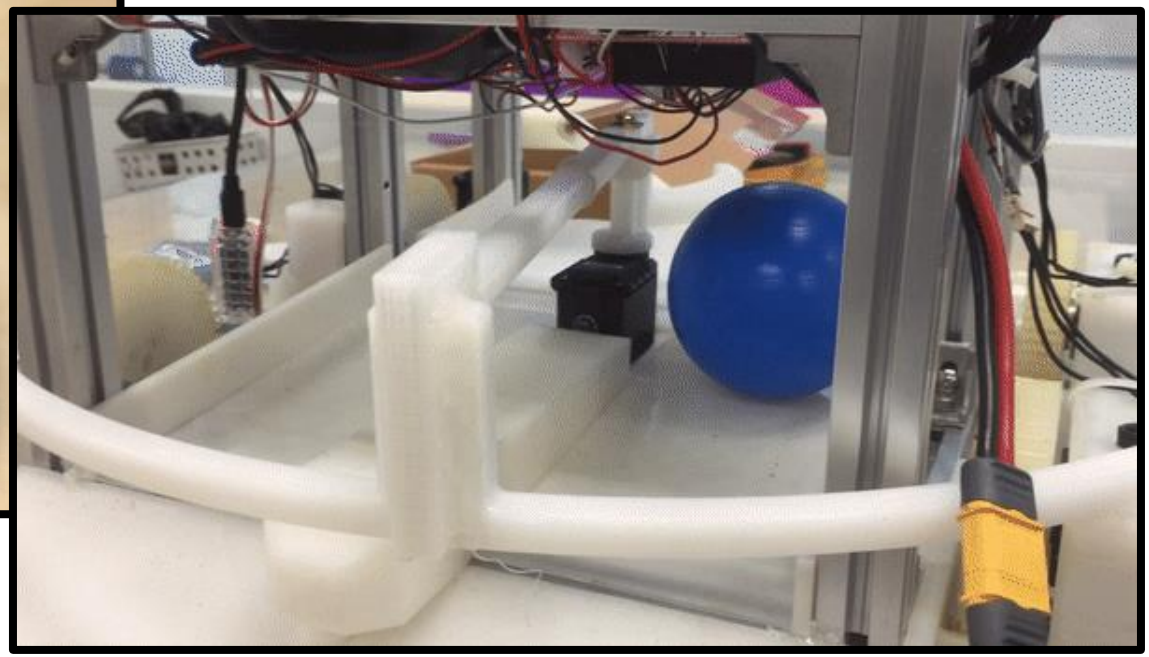
Submit



Engineering Design Issue

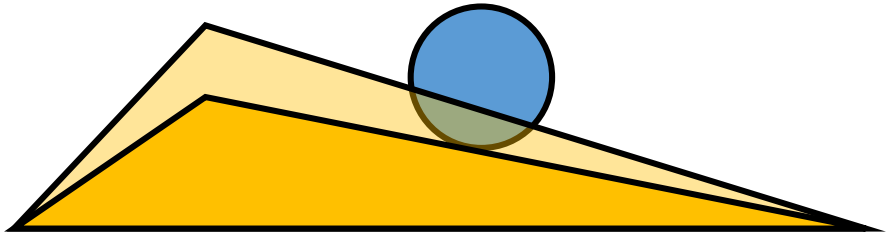
Engineering Design Issue





Feature to improve

unreliable ramp design (reliability)



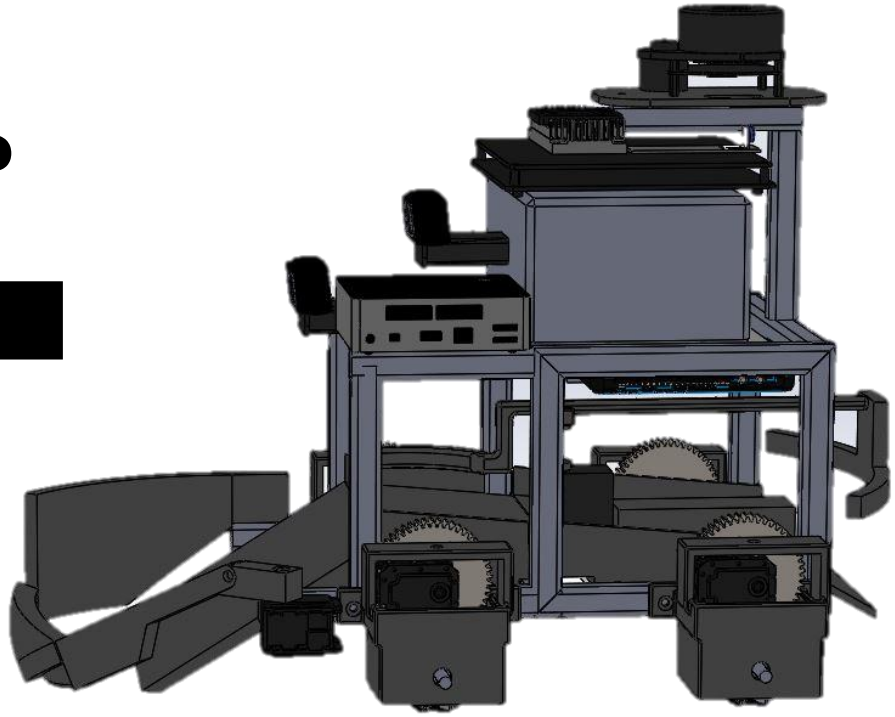
Undesired Result

uncertain engineering specification
(use of energy by moving object)

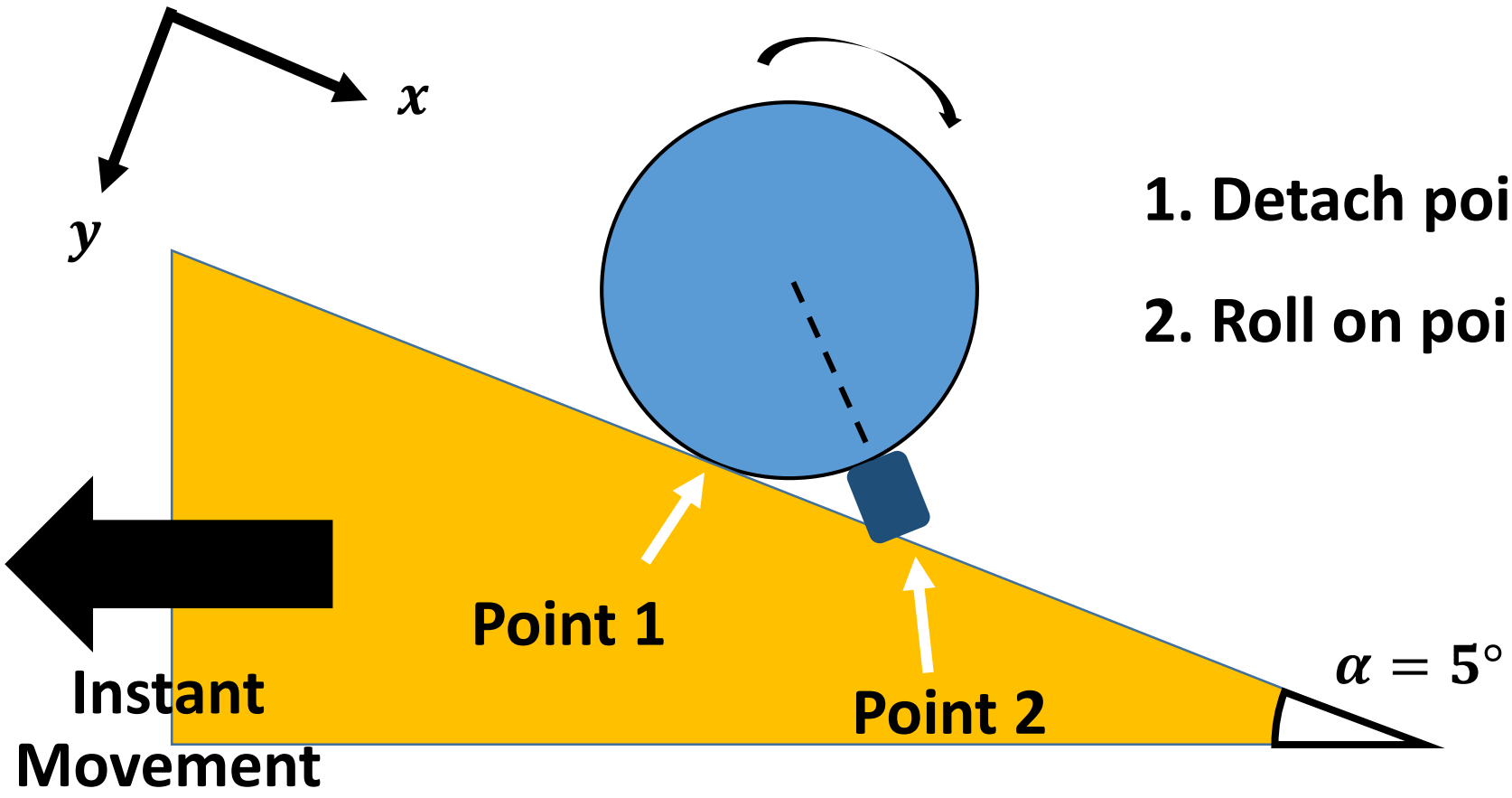
➡ **solution : Periodic action**

Move the vehicle back and forth

a = ?

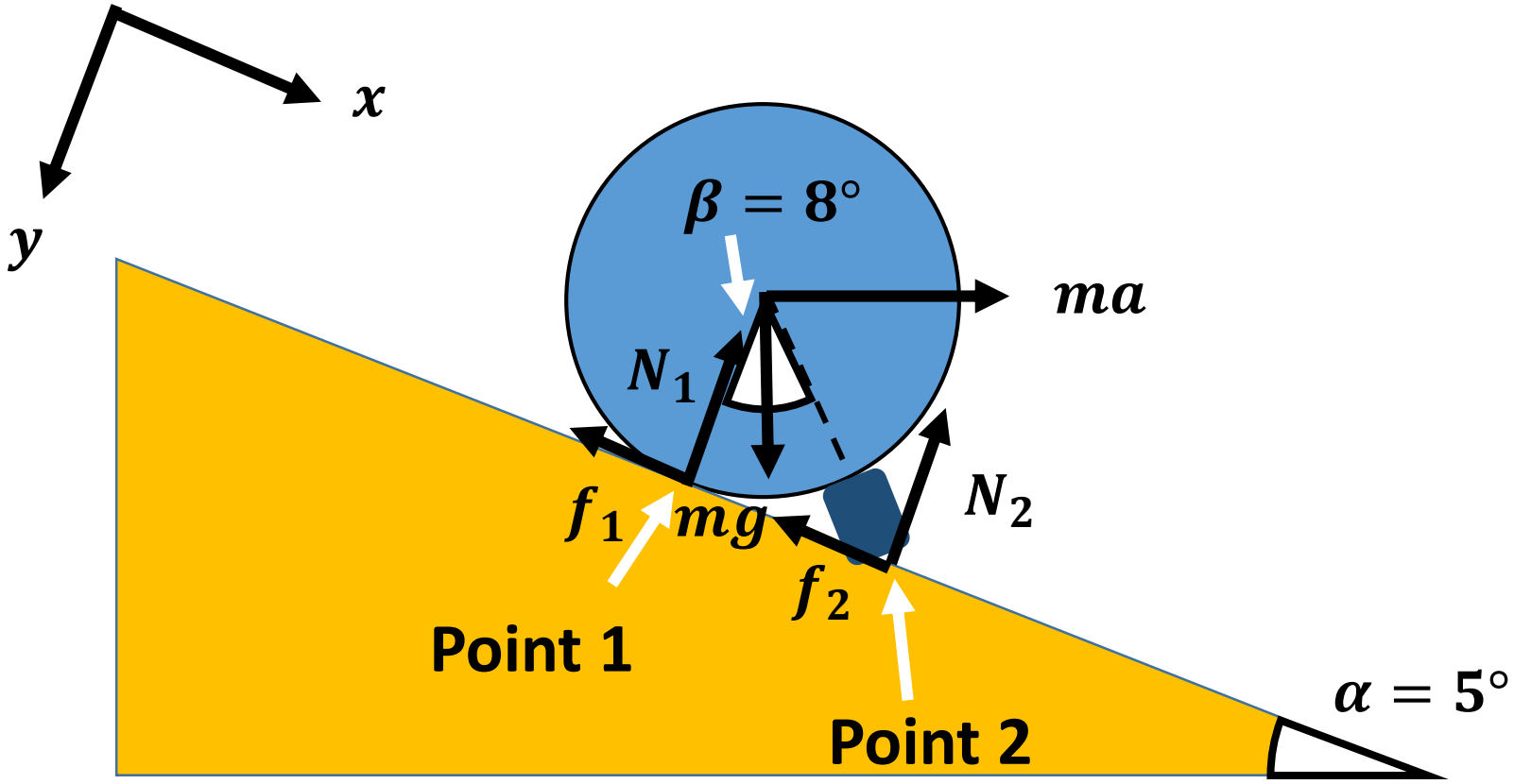


Problem Interpretation

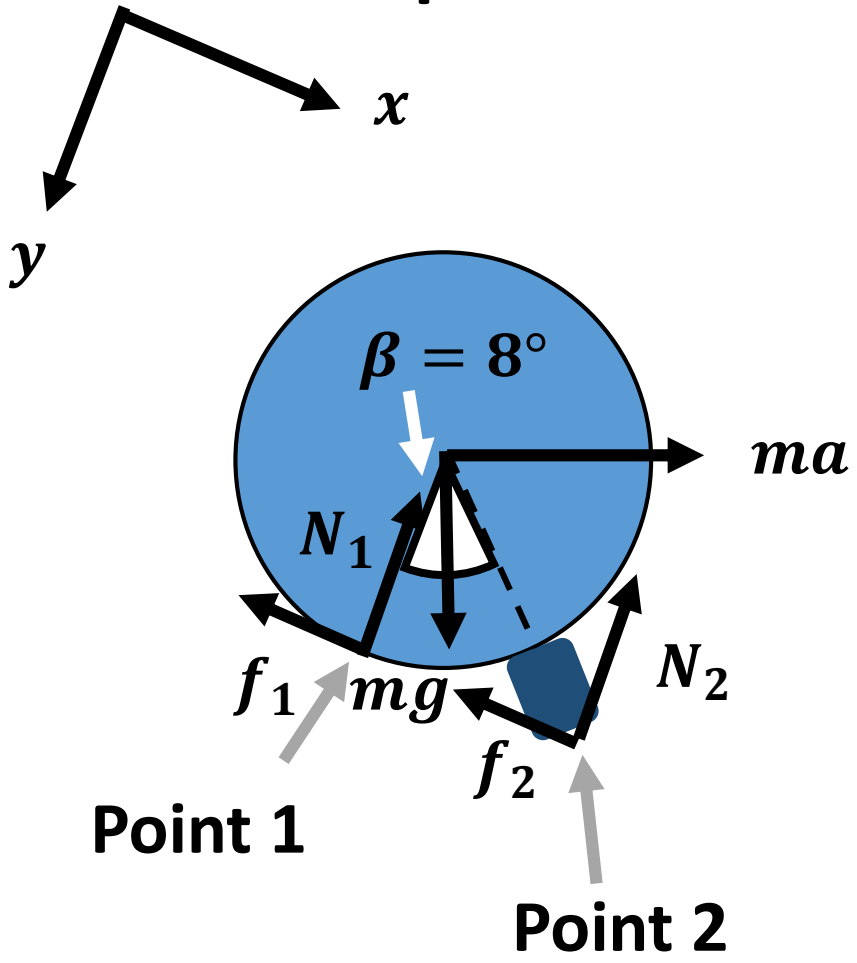


1. Detach point 1
2. Roll on point 2

Free Body Diagram



Acceleration Requirement for the ball to detach on point 1



$$point\ 1 \quad \sum torque$$

$$r\tan\beta N_2 = ma\cdot r\cos\alpha + mg\cdot r\sin\alpha$$

$$\sum F_y = 0$$

$$N_1 + N_2 = ma_y$$

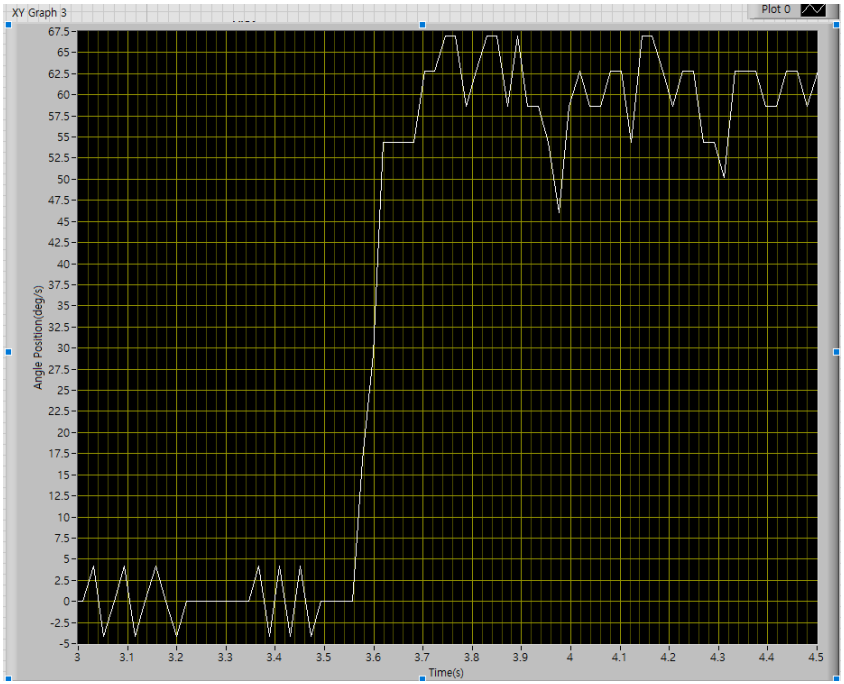
$$N_1 = ma_y - N_2$$

$$N_2 > ma_y$$

$$N_2 = \frac{ma\cos\alpha + mg\sin\alpha}{\tan\beta} > m(g\cos\alpha - a\sin\alpha)$$

$$\Rightarrow a > 0.514 m/s^2$$

Acceleration Requirement for the ball to detach on point 1



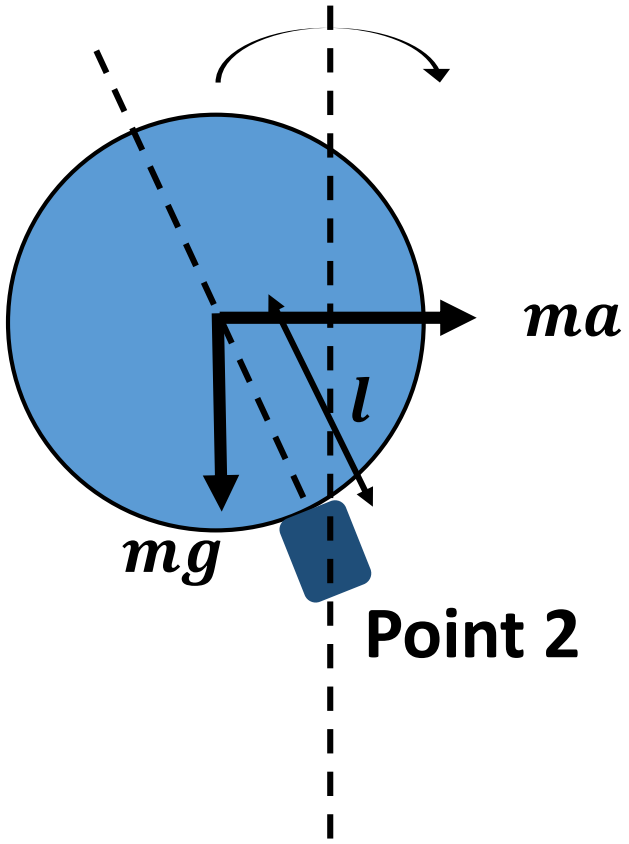
motor speed test

10RPM

$$a > 0.514 m/s^2$$

$$a = 0.76 m/s^2 \sim 0.91 m/s^2$$

Acceleration Time Requirement for the ball to overcome point 2 and roll over



$$\theta_0 = -8^\circ$$

$$I = \frac{2}{3}mr^2 + ml^2$$

$$I\ddot{\theta} = (ma_x \cos\theta - ma_y \sin\theta)l$$

$$a = 0.91 m/s^2$$

$$\ddot{\theta} = 28.13\cos\theta - 154.6\sin\theta$$

$$t = 0.0472s < t_{acceleration} = 0.05s$$

$$a = 0.76 m/s^2$$

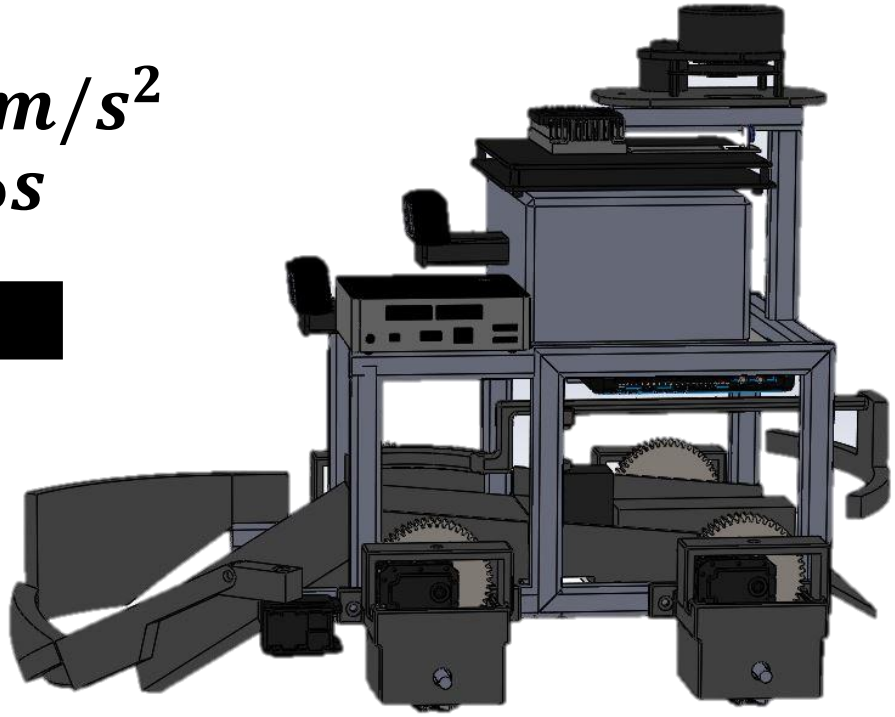
$$\ddot{\theta} = 25.72\cos\theta - 154.8\sin\theta$$

$$t = 0.0493s < t_{acceleration} = 0.06s$$

“10RPM”

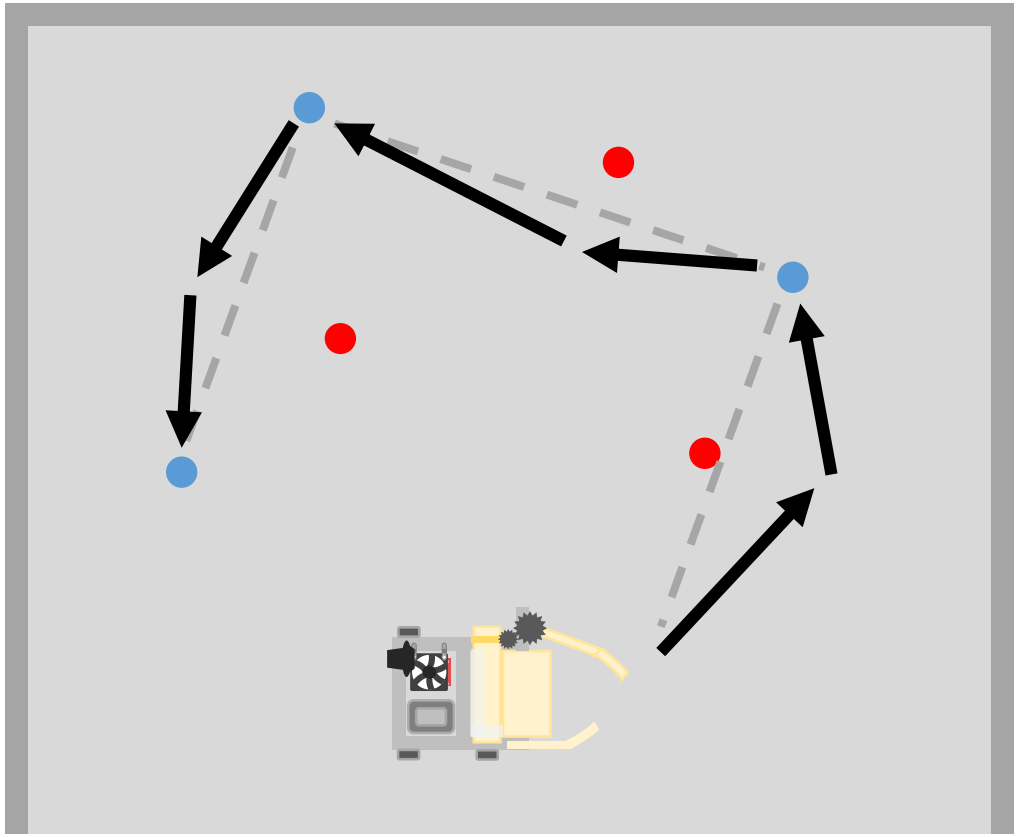
$$a = 0.9m/s^2$$

$$0.06s$$



DQN involved Ball Collection

Previously on Capstone Design 1…

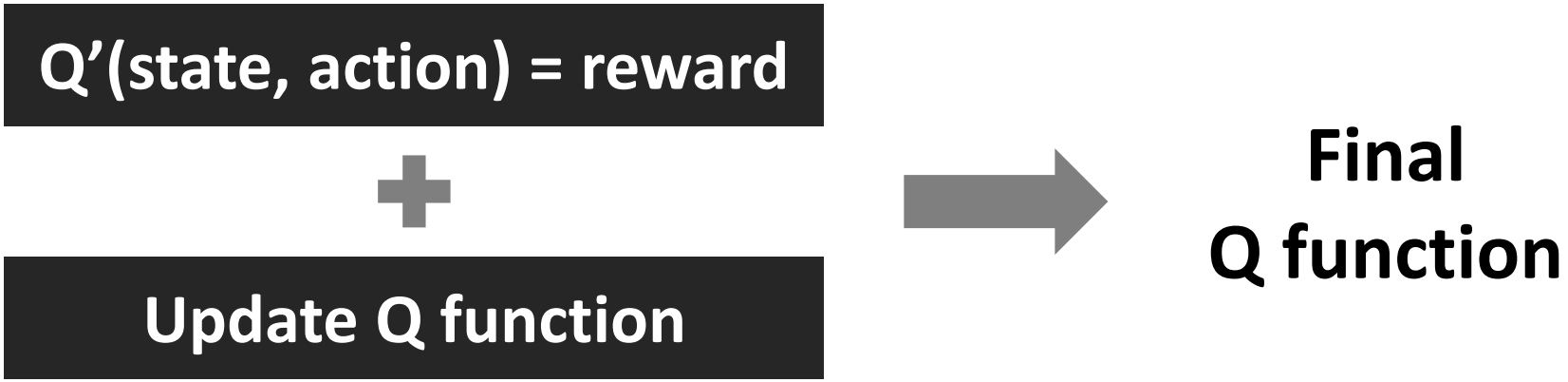


Precise,
but too
basic* and *primitive

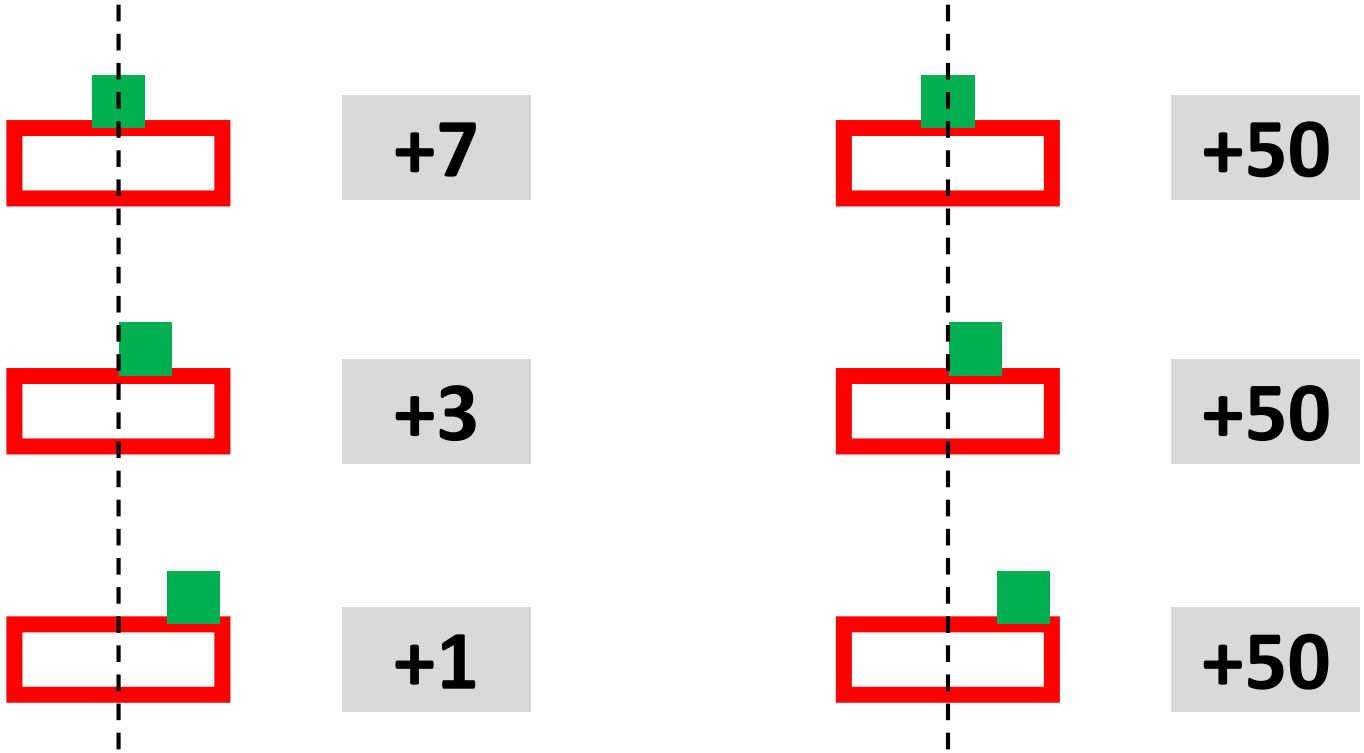
“Reinforcement Learning”

= training based on sequential actions and corresponding rewards

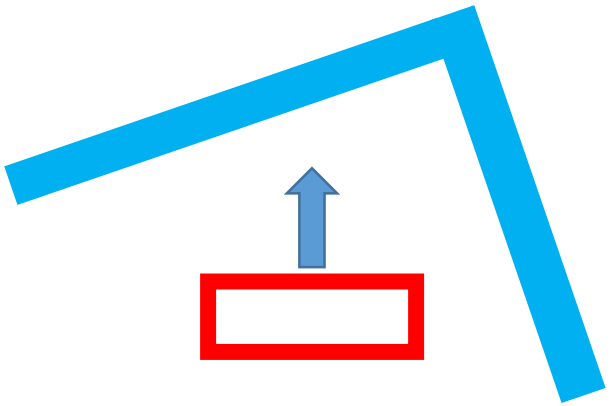
(*no fixed answers*)



Positive Rewards

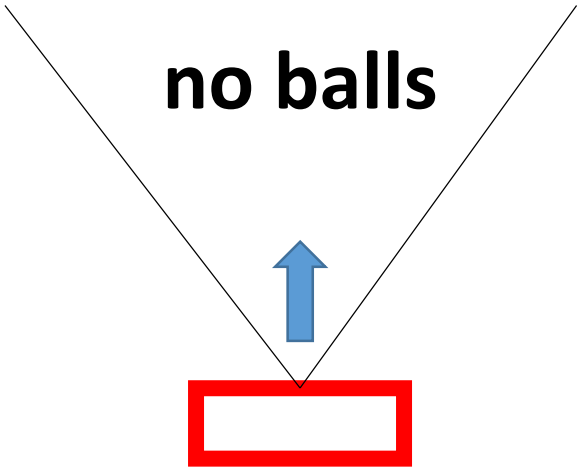


Negative Rewards



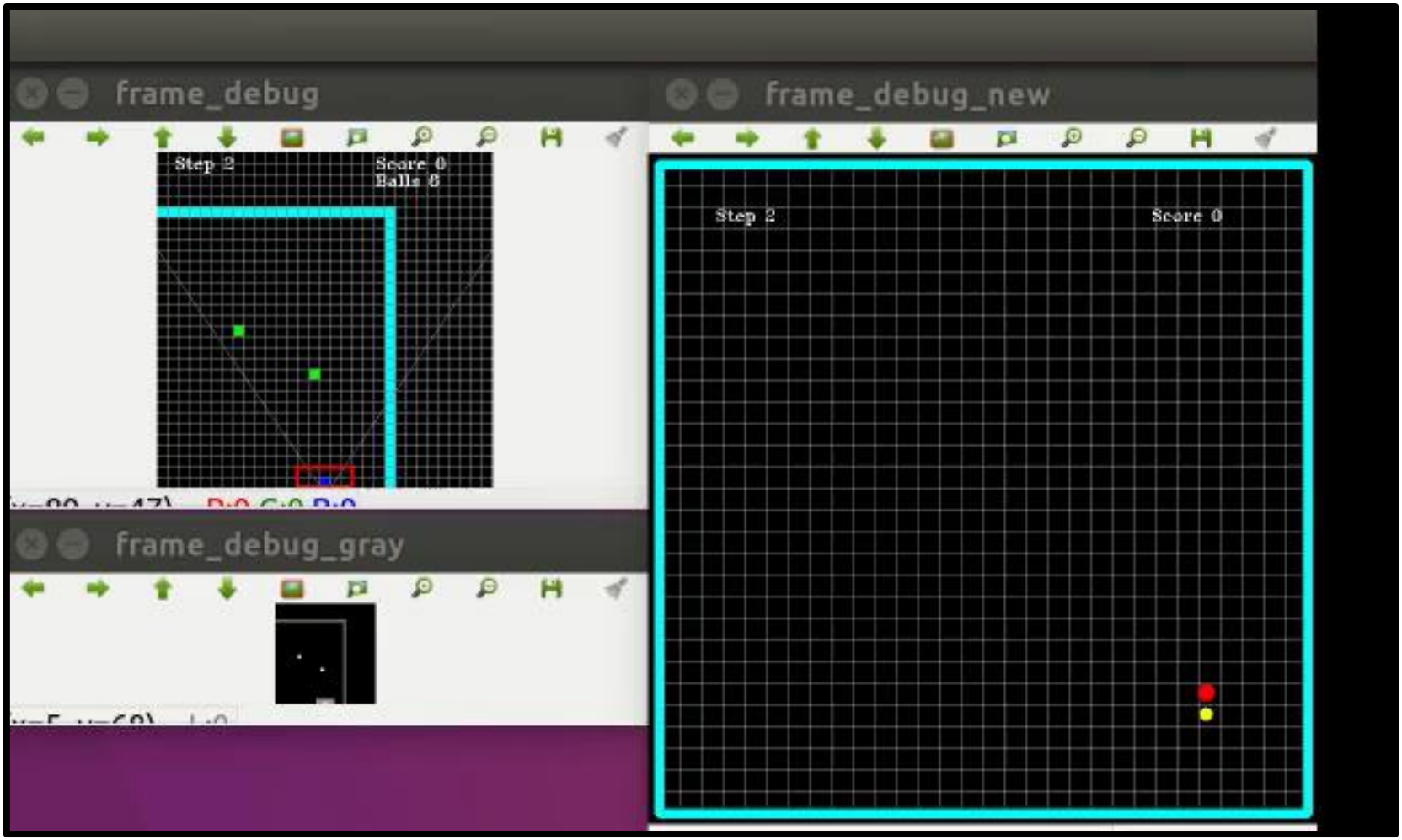
-1

-1



-1

DQN involved Ball Collection



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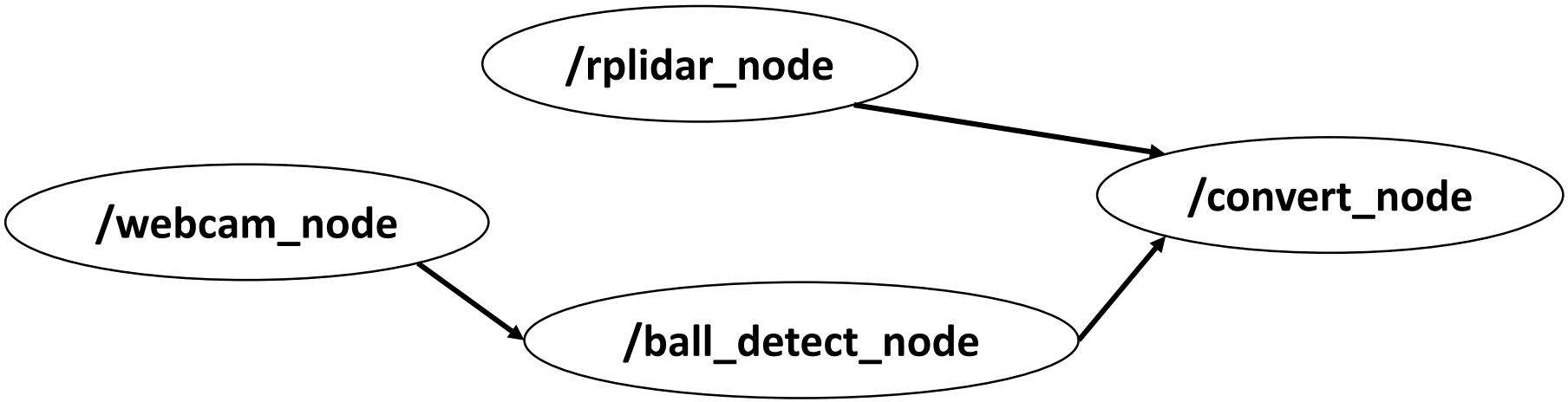
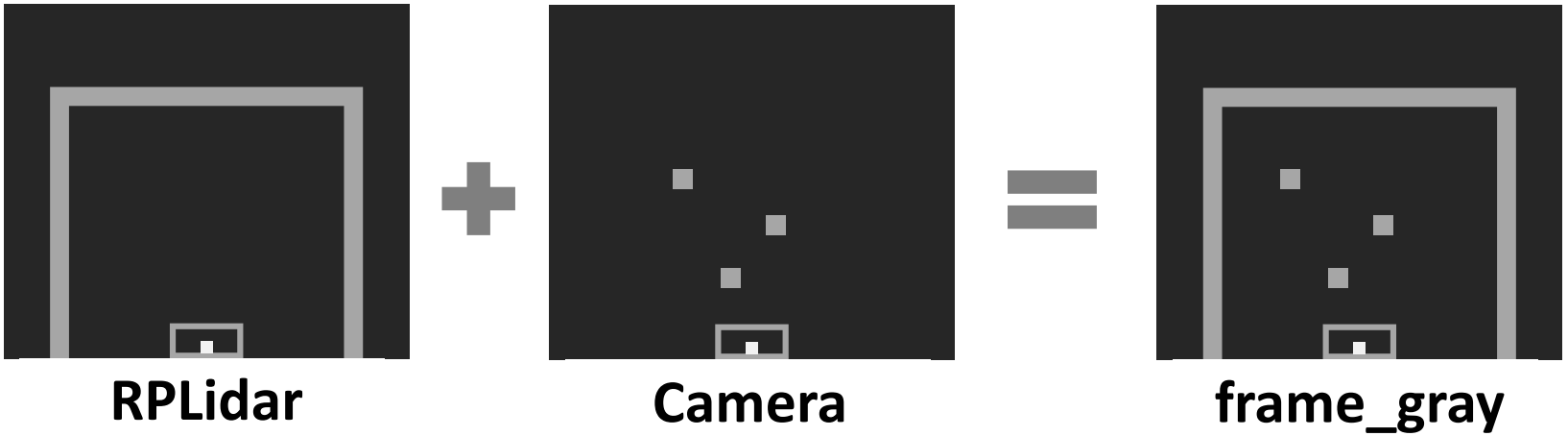
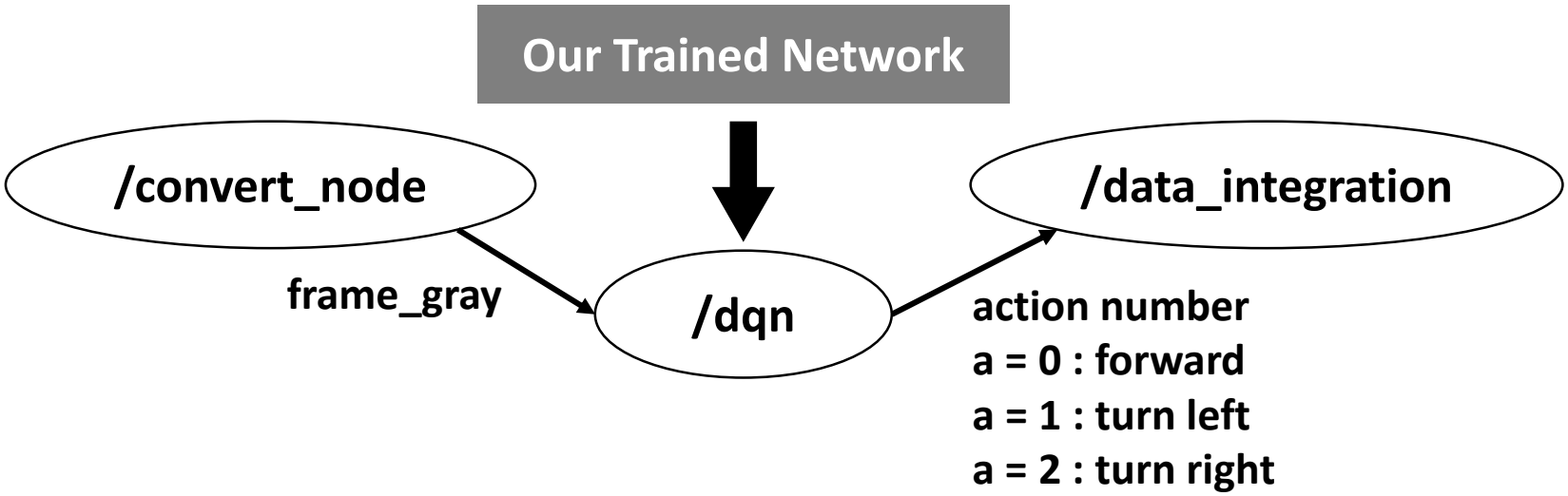
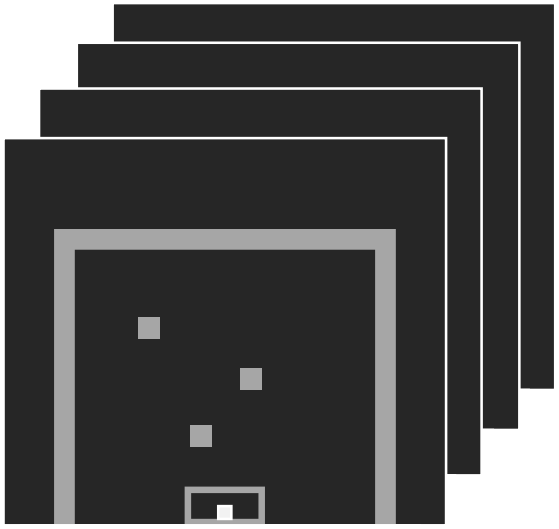




DQN involved Ball Collection



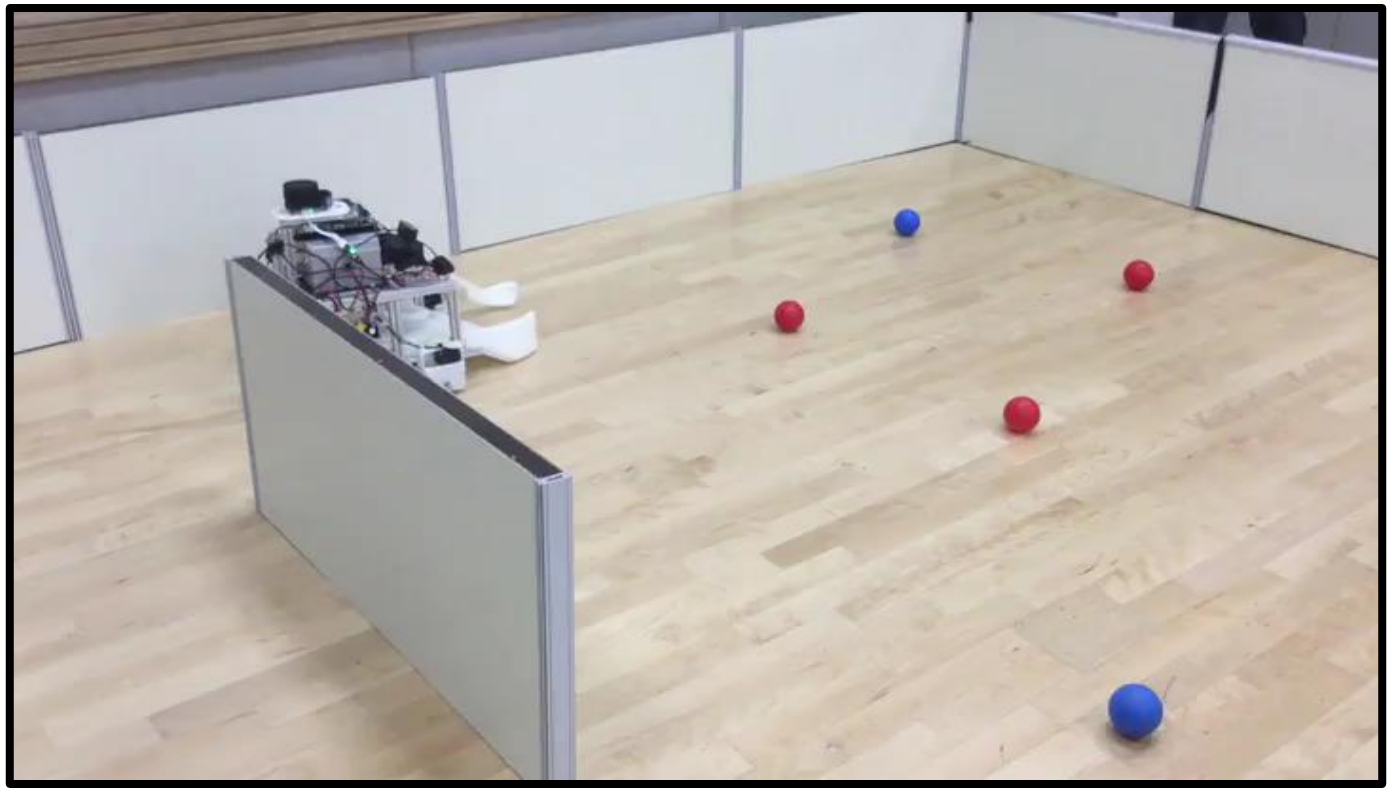


frame_gray X 4

action number

DQN involved Ball Collection

5X



Thank You