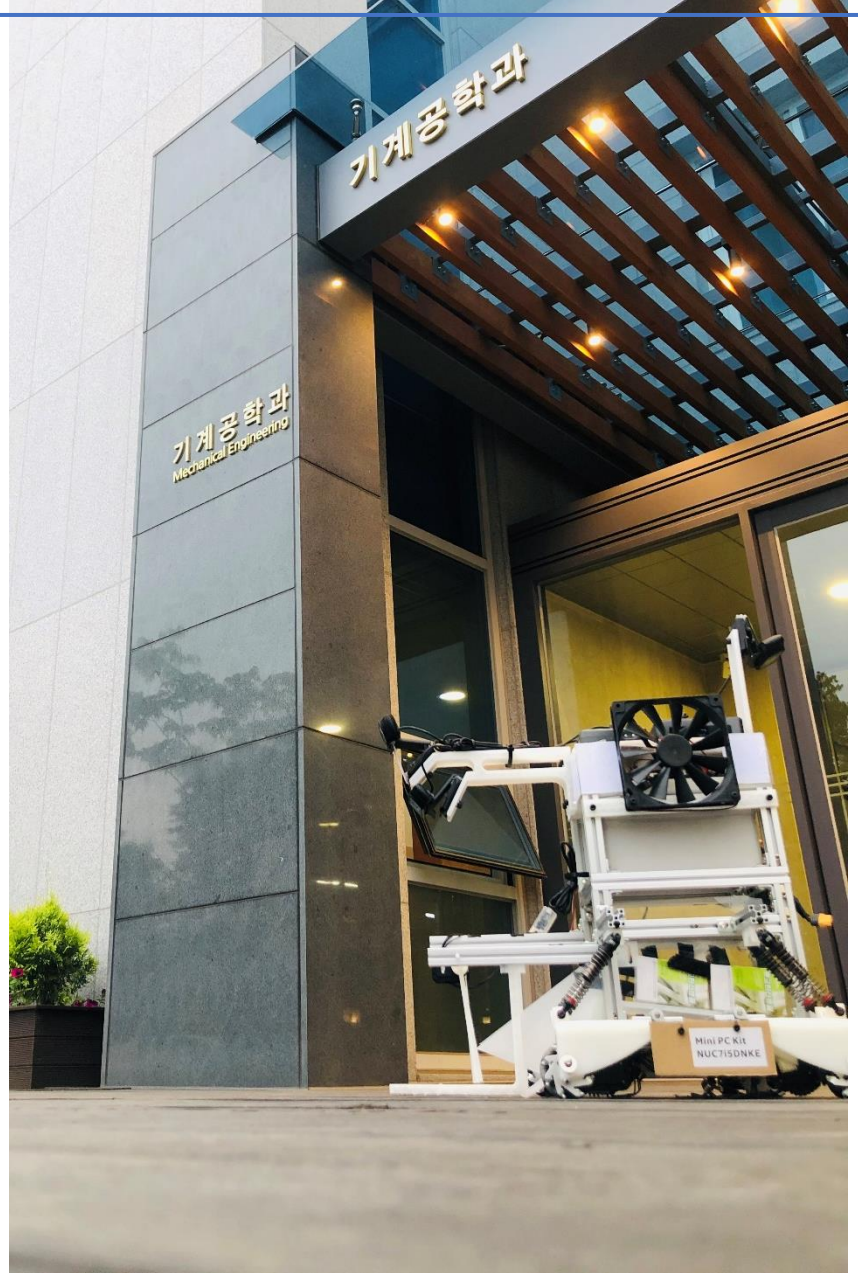
Capstone Design

3rd Review

Group C **(Mentored by Prof. Junho Oh)**



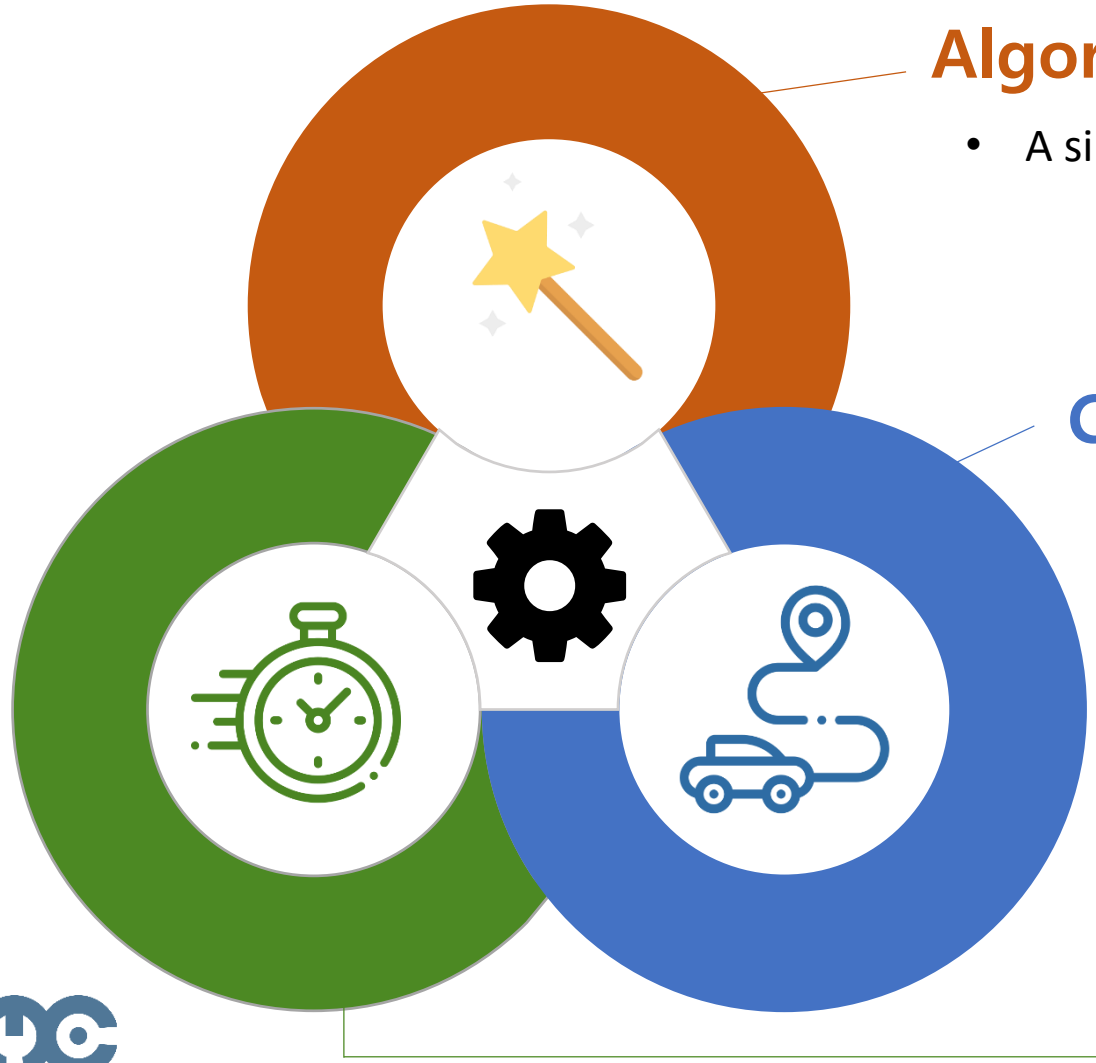
Contents

Algorithm

ROS , LabView, and OpenCV

ALGORITHM PHILOSOPHY

On What Ground does our algorithm work?



Algorithm that works in FUNDAMENTAL BASIS

- A single algorithm can run **BOTH in expected and unexpected scenarios**

Continuous & natural movement

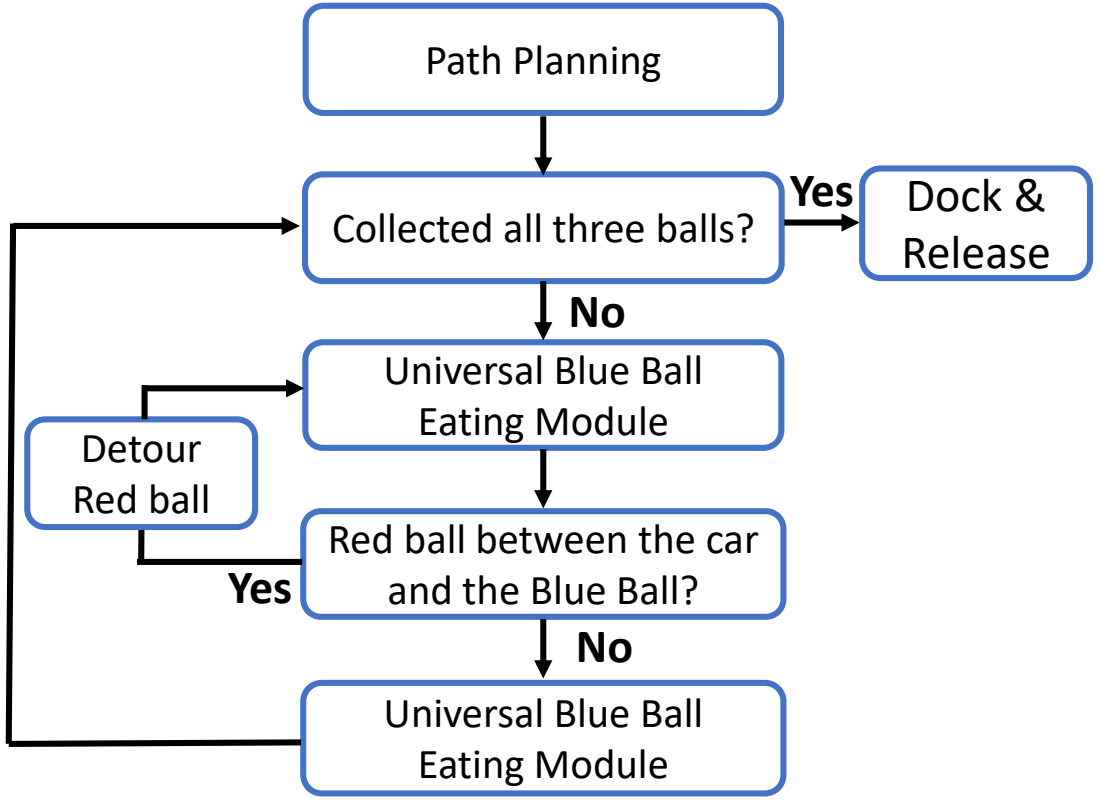
- Make it look as if a man drives.

Fast Operation

- Finish the mission as soon as possible

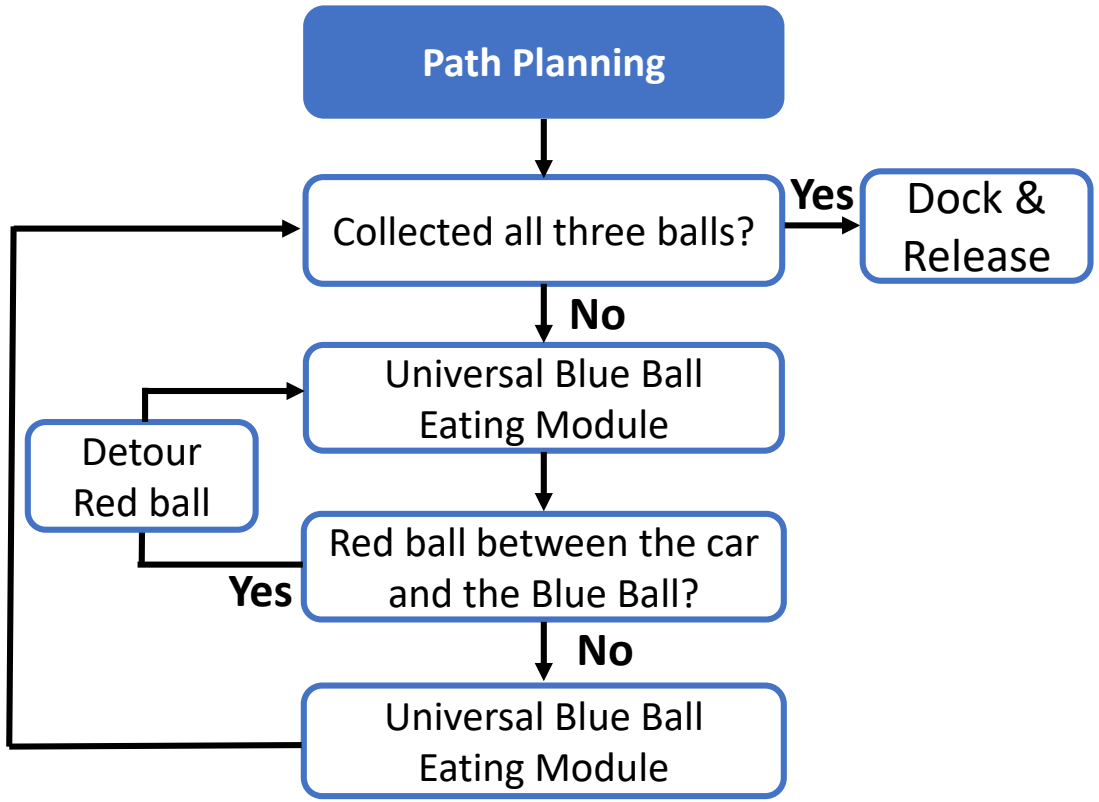
ALGORITHM EXPLAINED

Structure of Overall Algorithm



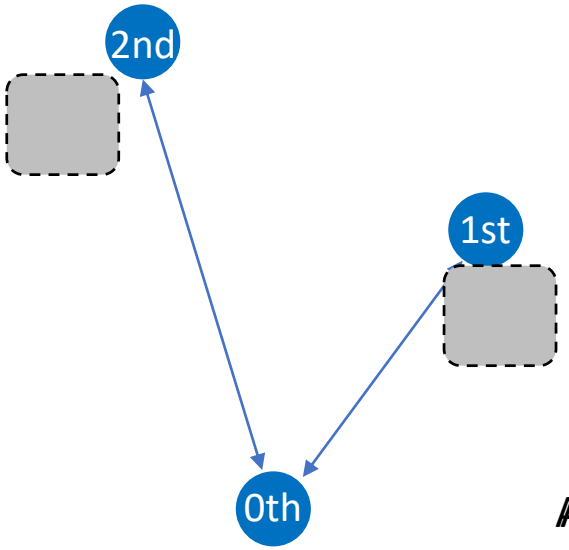
ALGORITHM EXPLAINED

① Path Planning



1: CW
-1: CCW

path_info = [1,-1,-1]



Keep this path information!

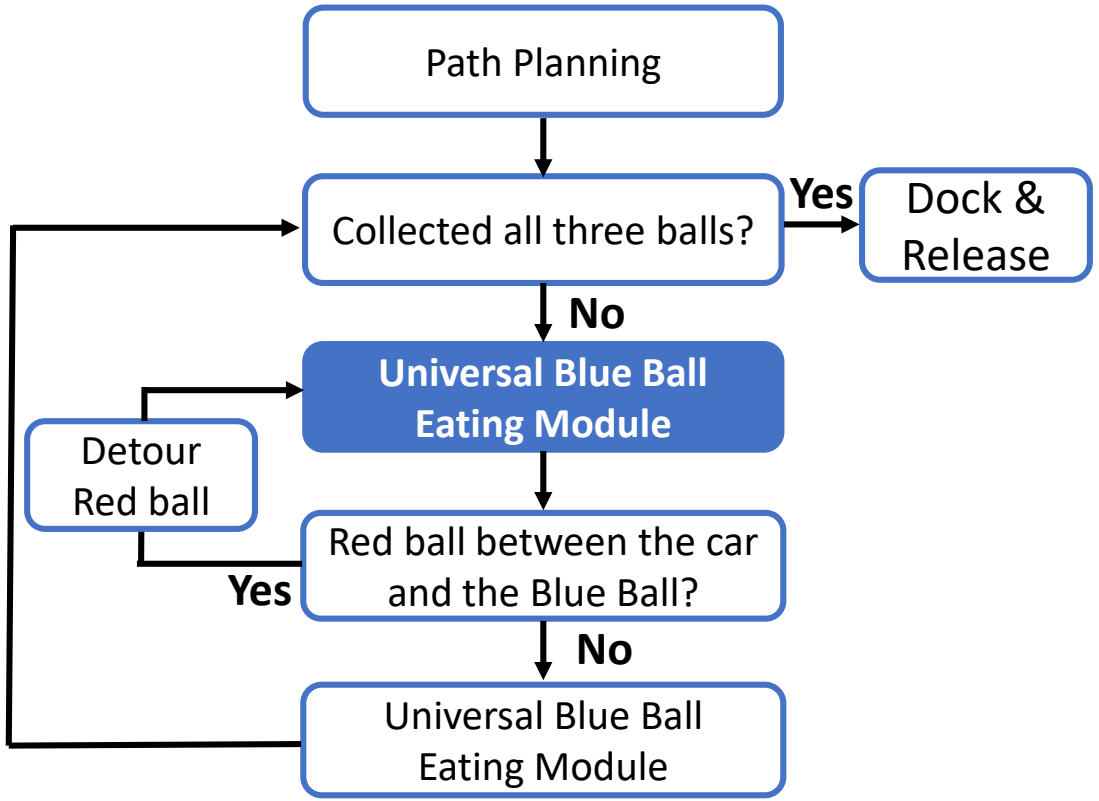
Then, we always travel

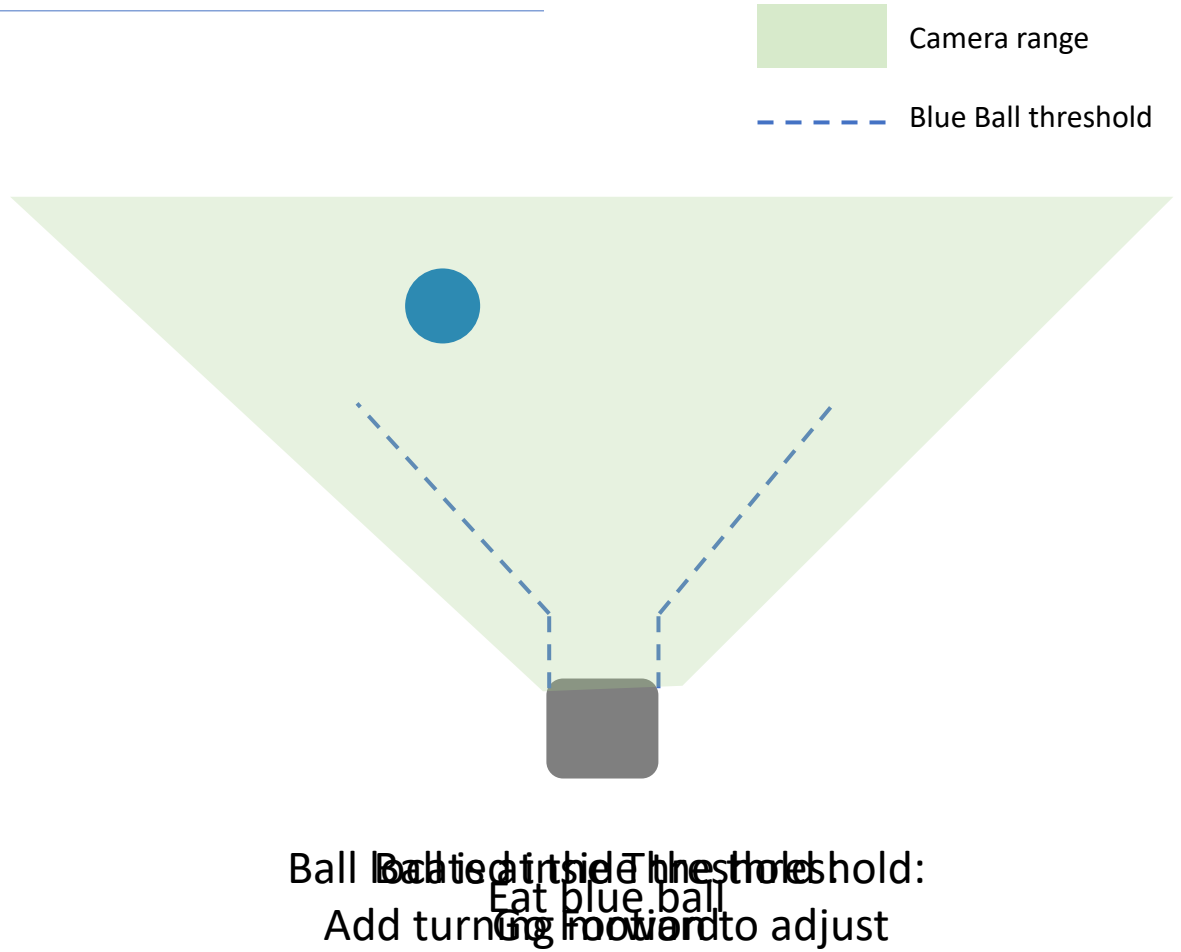
the robot would pick up 0th ball

1. shortest distance for each step
2. Without unnecessary rotations

ALGORITHM EXPLAINED

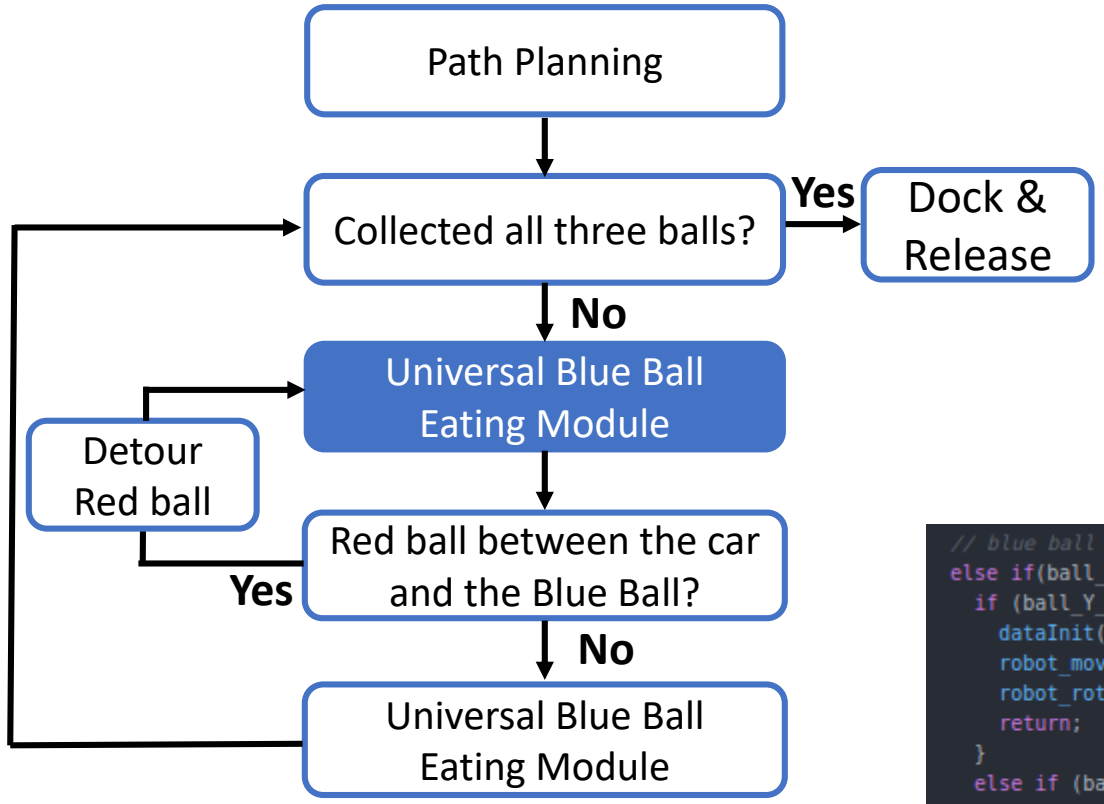
① Universal Blue Ball Follow Algorithm

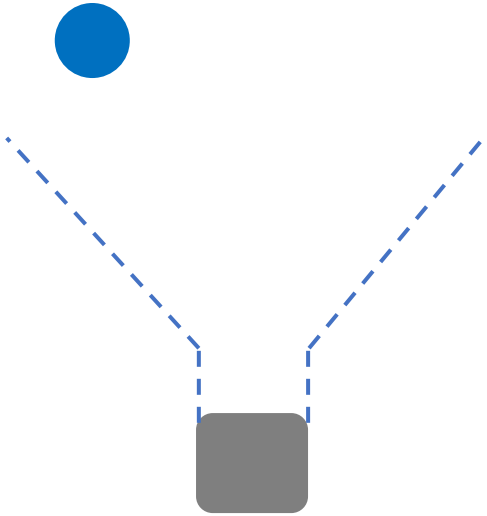




ALGORITHM EXPLAINED

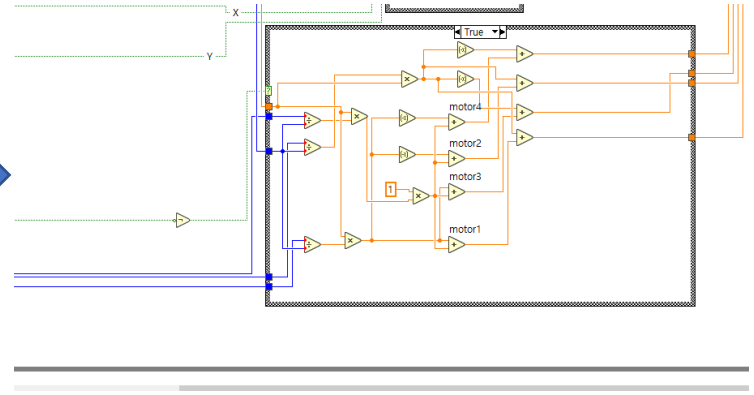
① How we improved LabView to drive & pick up smooth





$$v_{(approach\ velocity)} \propto ky_{(y-factor\ distance\ from\ ball\ to\ car)}$$

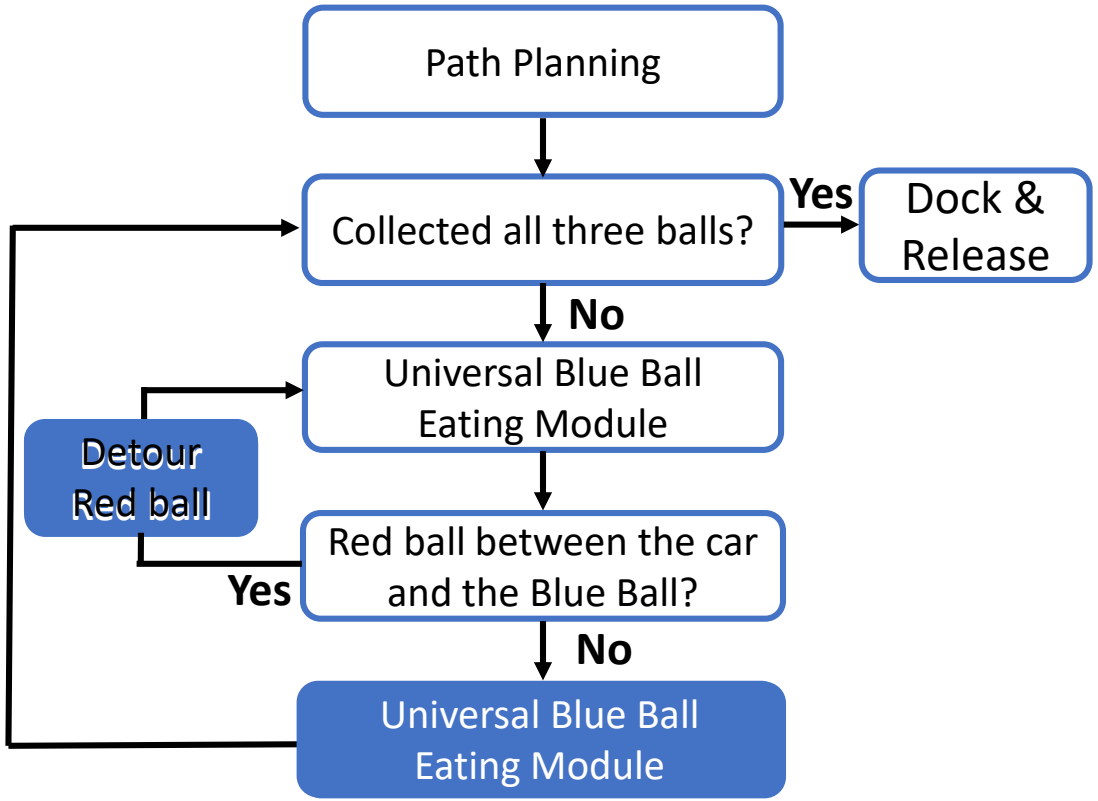
```
// blue ball is on your right
else if(ball_X_2_blue[0] > 0){
  if (ball_Y_2_blue[0] > 1){
    dataInit();
    robot_move_forward(1);
    robot_rotate_CW(0.51);
    return;
  }
  else if (ball_Y_2_blue[0] > 0.5){
    dataInit();
    robot_move_forward(1.4*(ball_Y_2_blue[0] - 1) + 1);
    robot_rotate_CW(0.25);
    return;
```

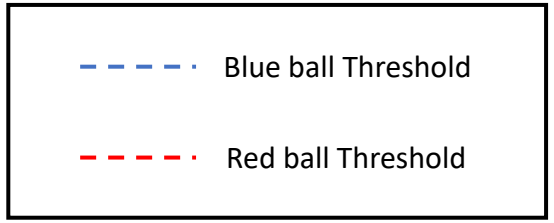


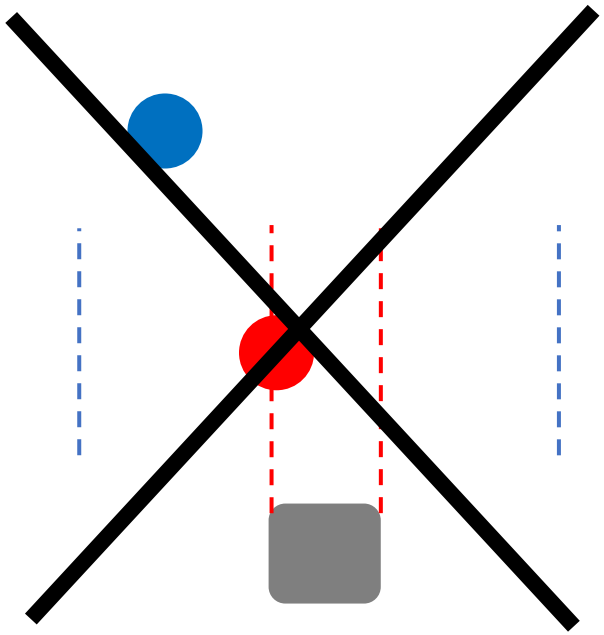
LabView receives values from 0 to 1 instead of Boolean (True, False)

ALGORITHM EXPLAINED

② Universal Red Ball Detour Algorithm

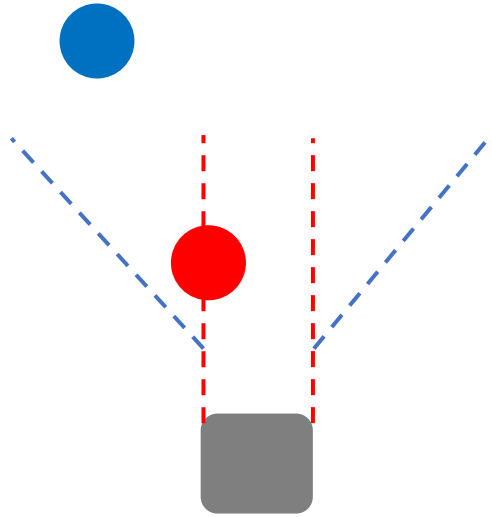






This way we have to write another code to re-locate blue ball

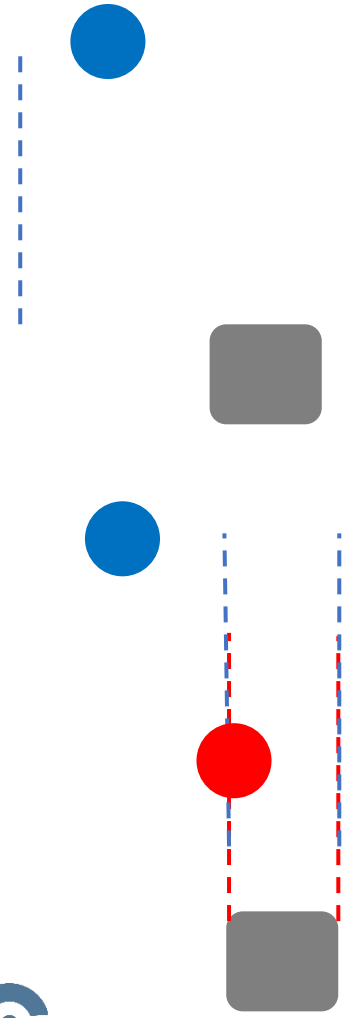
Does not fit our PHILOSOPHY

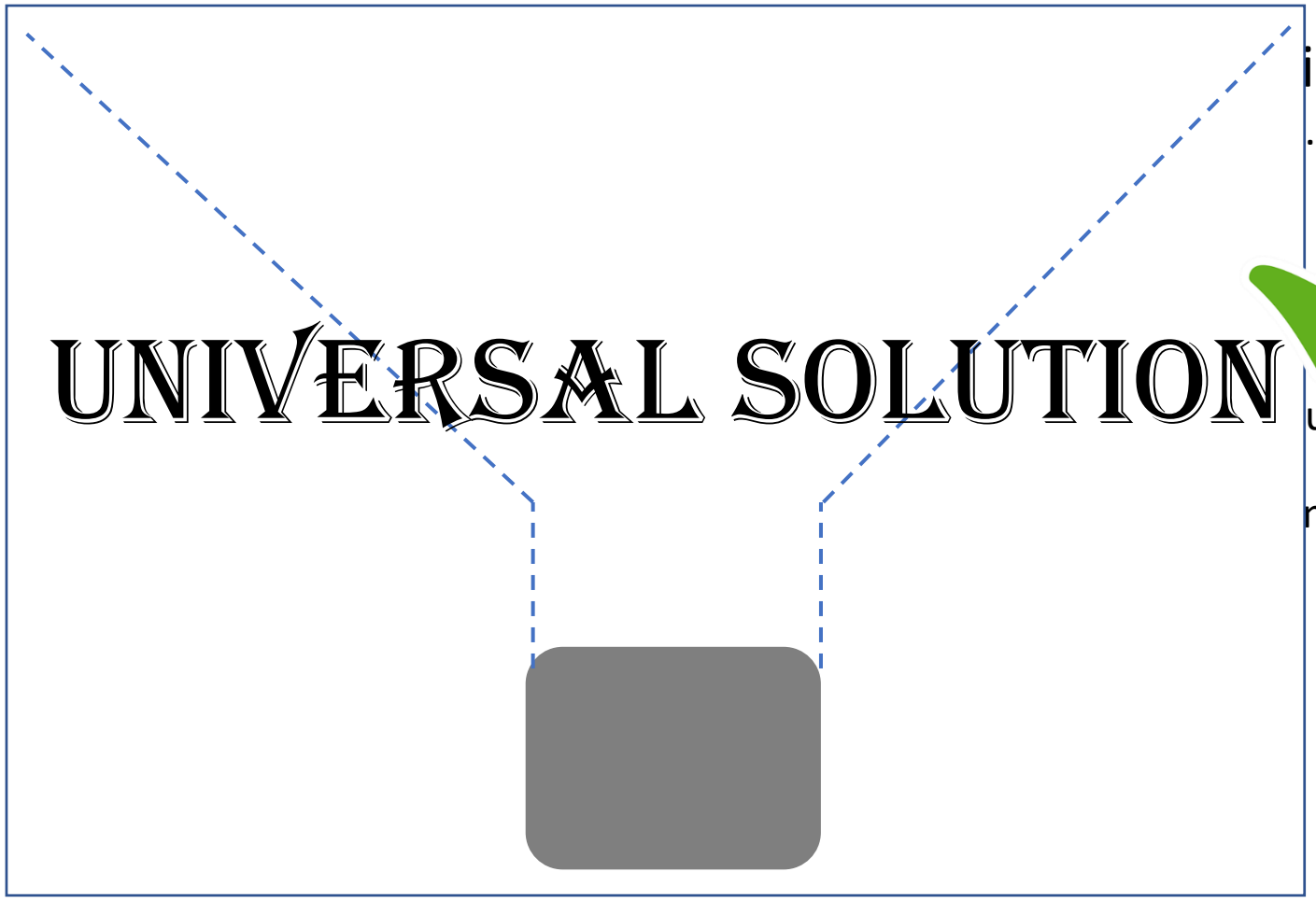


Blue ball always in threshold!!!!

ALGORITHM EXPLAINED

Why linearly expanding blue ball threshold?





ing>

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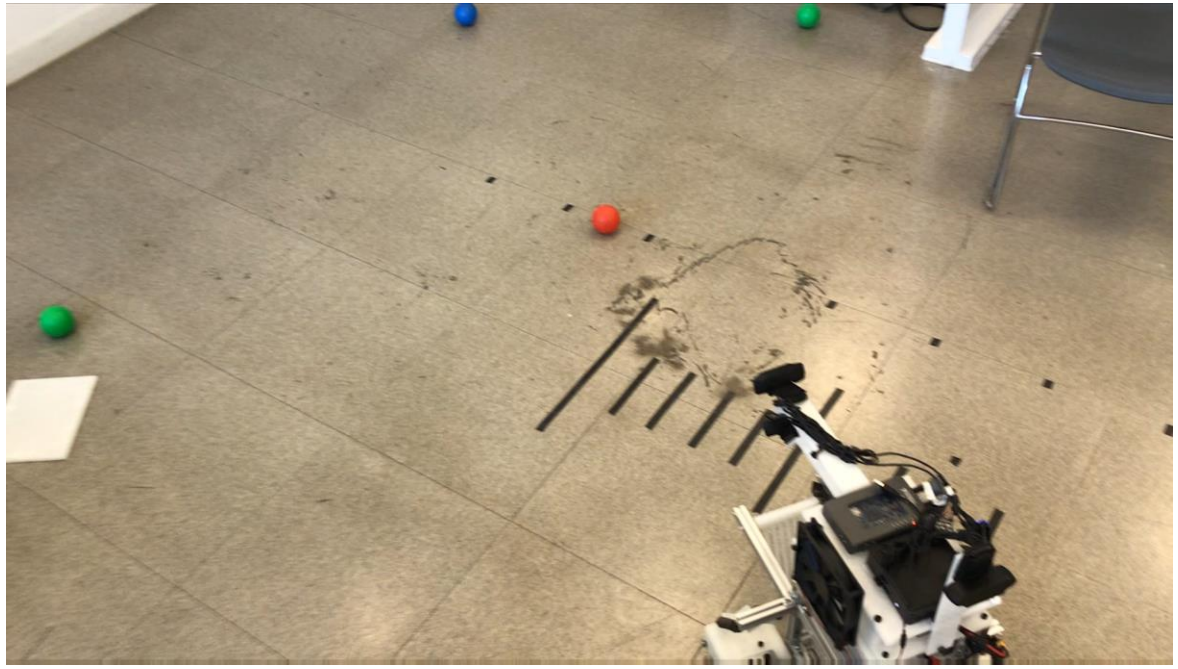
ue ball position

n

ALGORITHM EXPLAINED

Test on some extreme scenarios

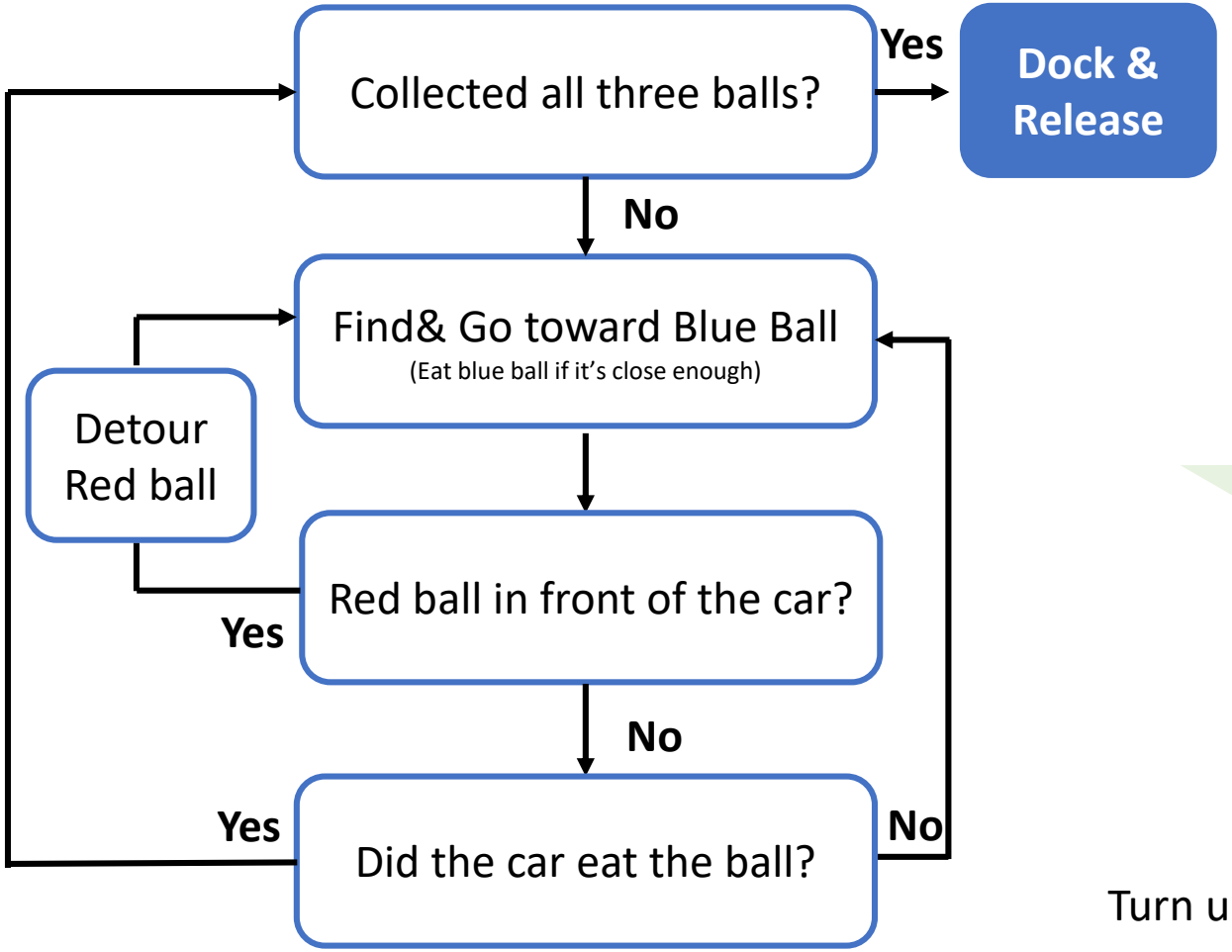


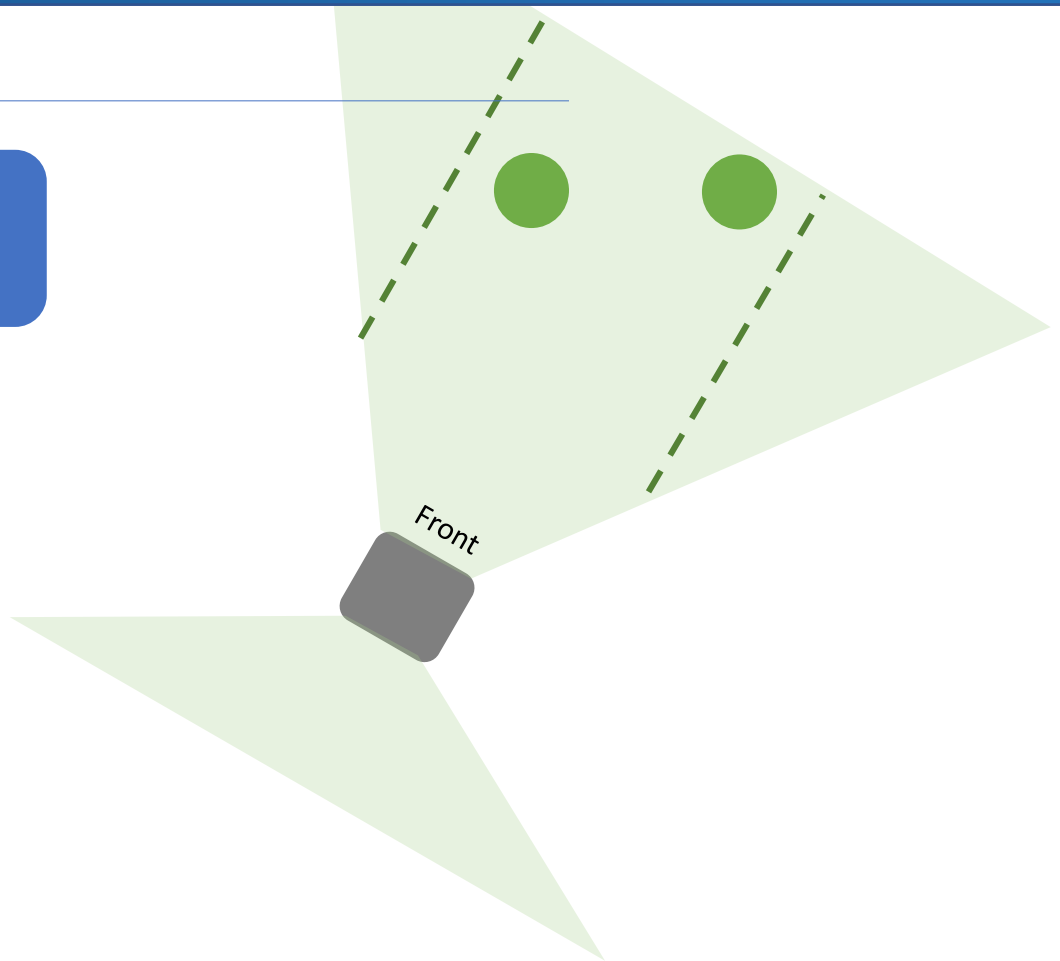
<Example 1> Blue ball right behind red ball

<Example 2> Two red balls in front of a blue ball

ALGORITHM EXPLAINED

③ Dock & Release Algorithm





If the green ball is about to leave threshold, adjust!

Turn until the car is PARALLEL & AT THE MIDPOINT OF GREEN balls

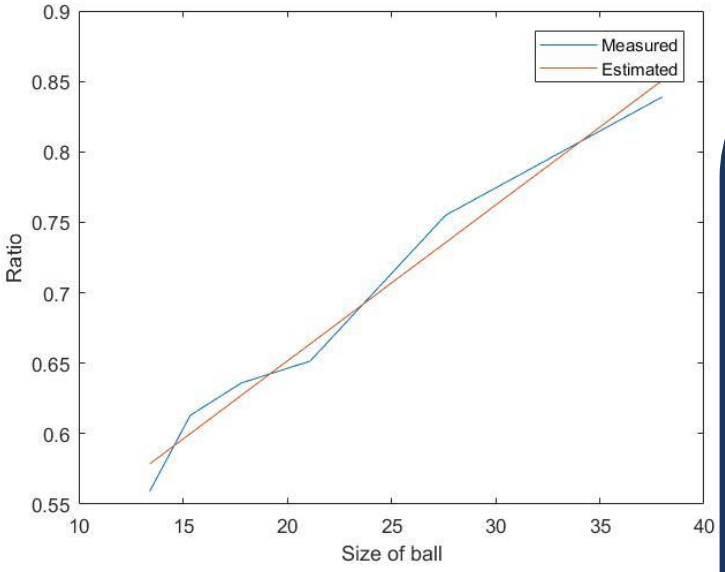
OPENCV IMPROVEMENTS

Improving distance error using Linear Square Method

```
y1 = [0.839;0.755;0.6515;0.636;0.613;0.559];
y2 = [0.837;0.75;0.687;0.633;0.604;0.584];
y3 = [0.823;0.781;0.728;0.667;0.611;0.596];
x1 = [38;27.6;21.1;17.8;15.35;13.4];
x2 = [39.2;27.4;20.34;17.11;15;12.81];
x3 = [39.2;28.7;22;17.7;15.02;12.81];
opt_m = 0;
opt_n = 0;
min = 99999;
for m=(0.05/30):0.0001:(0.3/5)
    for n = -5:0.00001:0.5
        error = 0;
        for i=1:6
            if i<= 3
                error  = error + (y1(i) - m*x1(i) - n)^2;

            elseif i>3
                error  = error + 2*(y1(i) - m*x1(i) - n)^2;
            end
        end
        if error < min
            opt_m = m;
            opt_n = n;
            min = error;
        end
    end
end
```

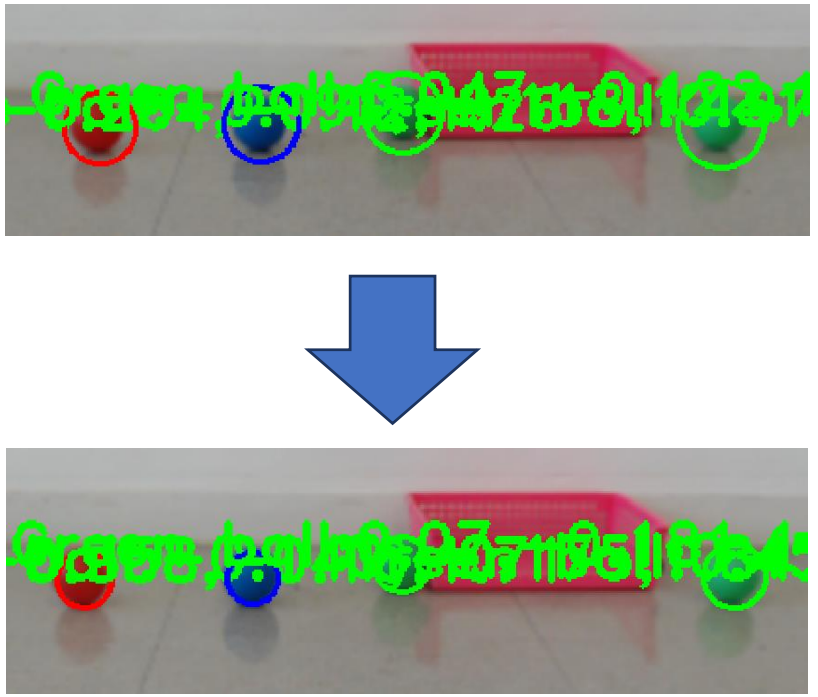
Matlab code



Estimated graph

```
ratio_r = 0.0111*radius_r[i] + 0.43;
ratio_b = 0.0099*radius_b[i] + 0.49;
ratio_g = 0.0093*radius_g[i] + 0.53;
```

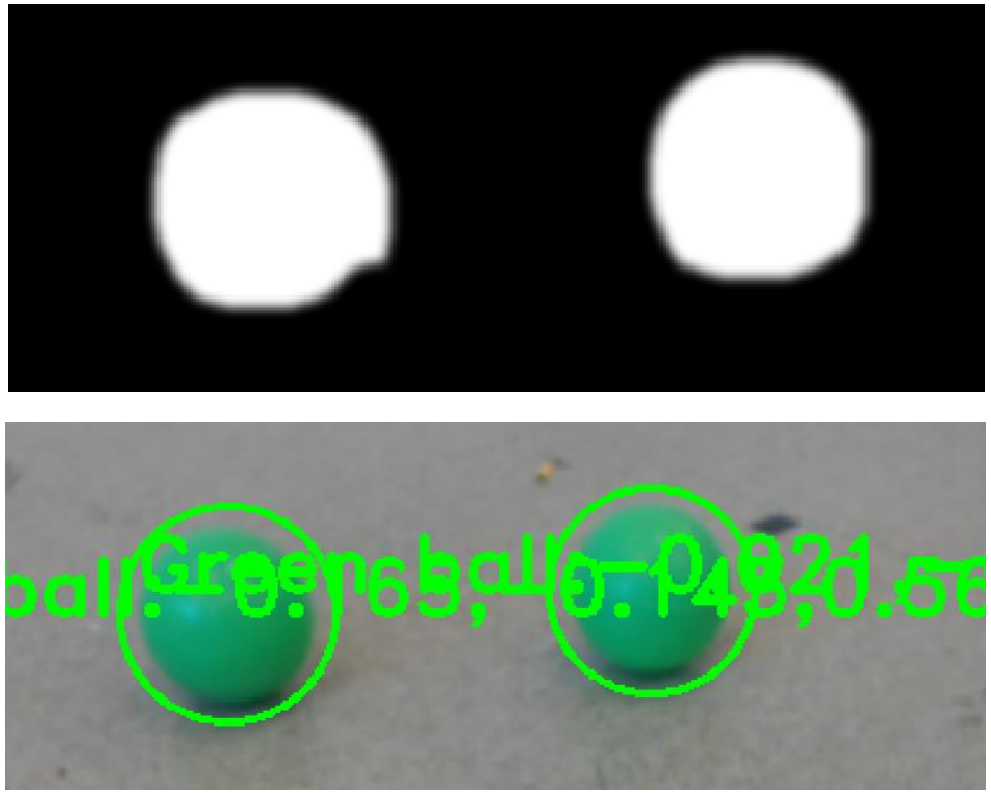
Apply on ball detection



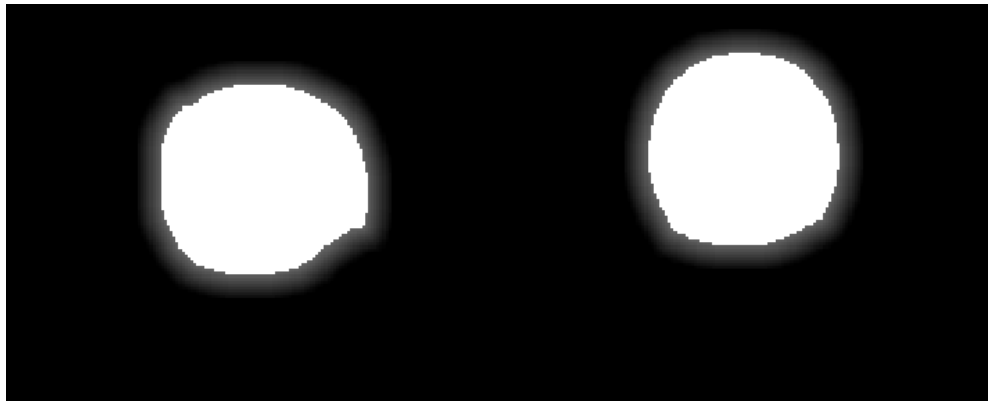
Before(top) & After(bottom)

OPENCV IMPROVEMENTS

Improving distance error by intensifying contrast



equalizeHist
Open CV function



Before

After

Strength in Hardware

Solidworks

BENEFITS FROM INSTALLING 3 CAMERAS

Why we finally decided to install 3 cameras was the best choice.

① : Needed to install cameras **high** enough
② : More stable docking for back blue ball exit

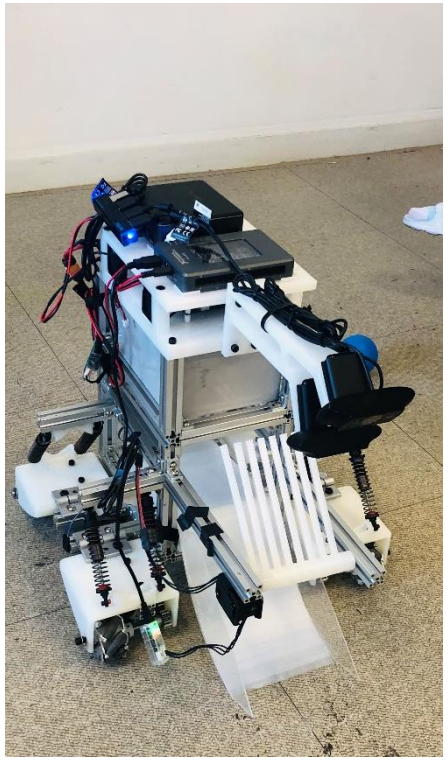


Figure 1. When the camera is too low

Figure 1. When the camera is high enough

Higher camera position

↓

Camera covers **smaller range**

↓

Requires two camera on the front
To cover full range

ACTUATOR MODULE DESIGN

How the car actuator can be in contact on uneven ground better

ACTUATOR MODULE DESIGN

How the car actuator can be in contact on uneven ground better

Fig 1. Forward drive on unequal path on right side

Fig 2. Turn drive on unequal path on one side

Fig 3. Turn drive on unequal path on left side

Fig 4. Equal weight distribution

Final Demonstration Video