Final Presentation

Group 잘했조

Professor Seibum Choi

20100048 Hyungkyu Kim

20140013 Geonhee Ko

20140929 Pouya

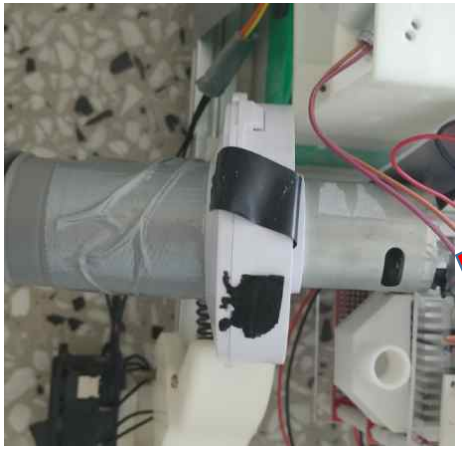
20140425 Ahyoung Lee

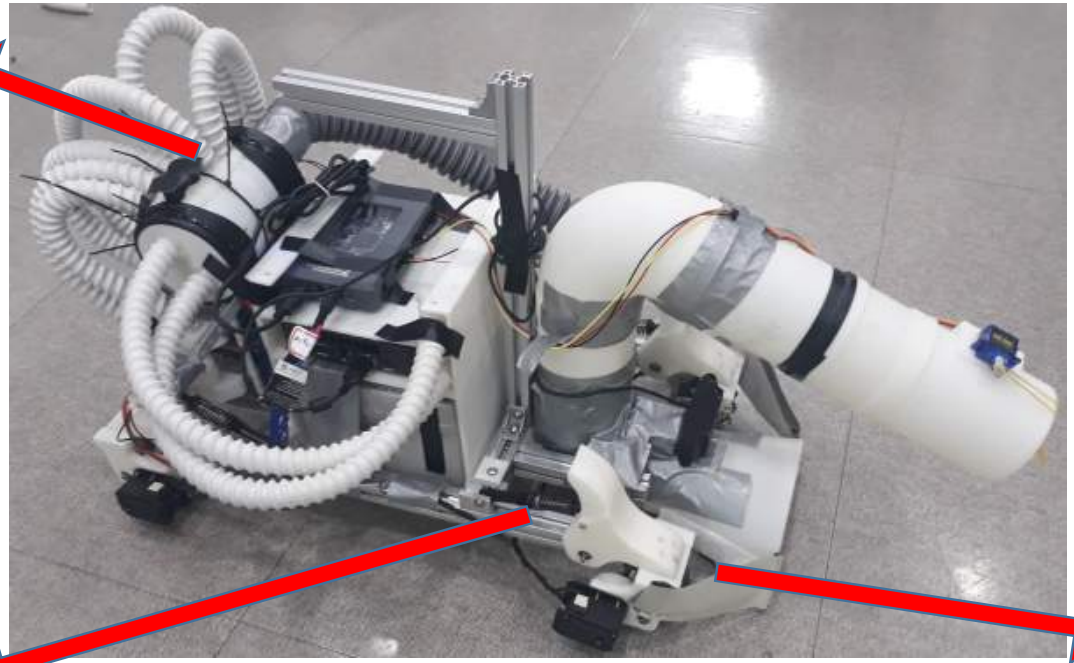
20150314 Sungbin Park

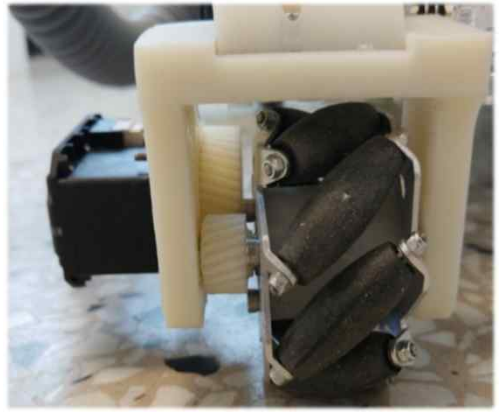
20150352 Jinwook Park

20150915 Ailian Chi

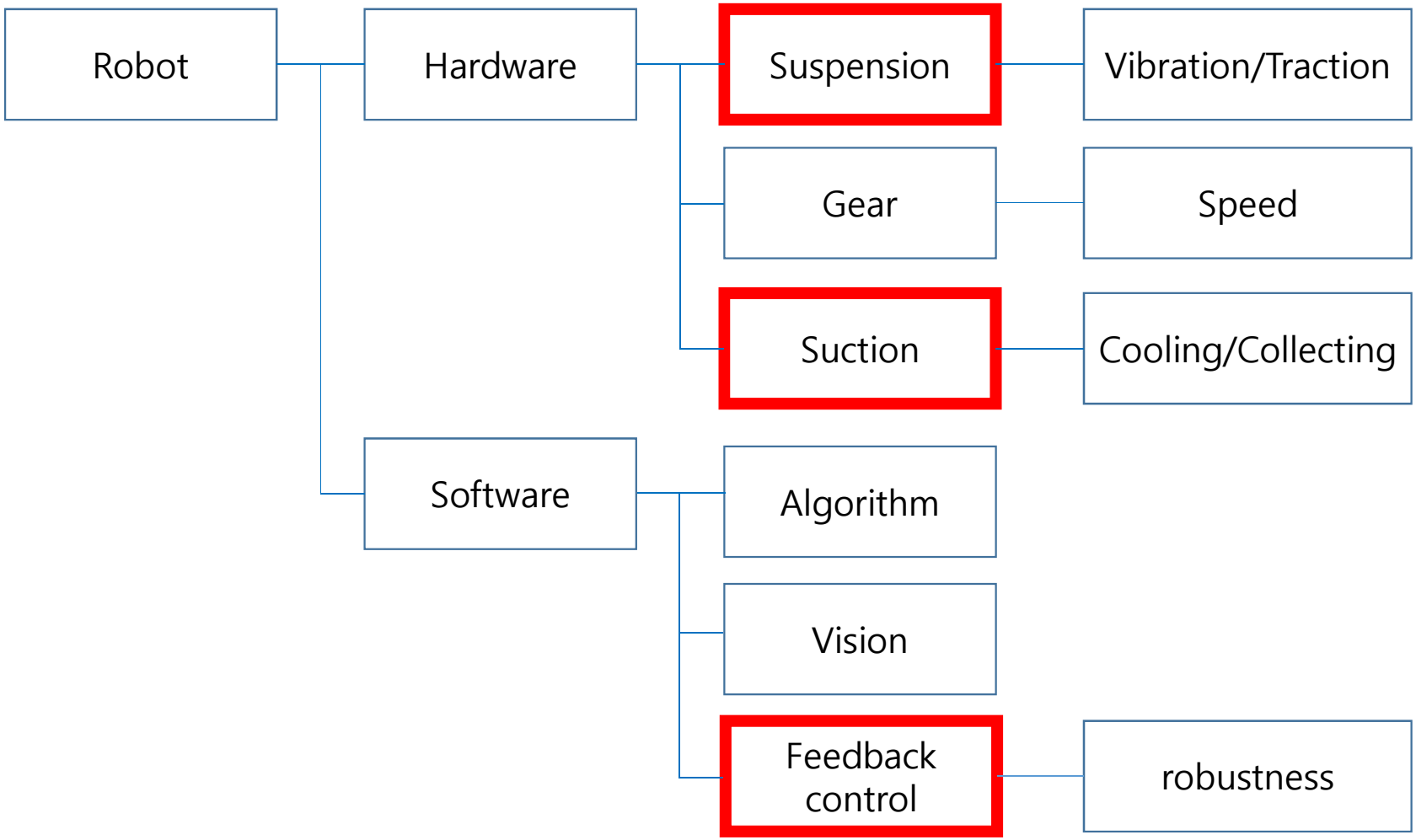
System Introduction



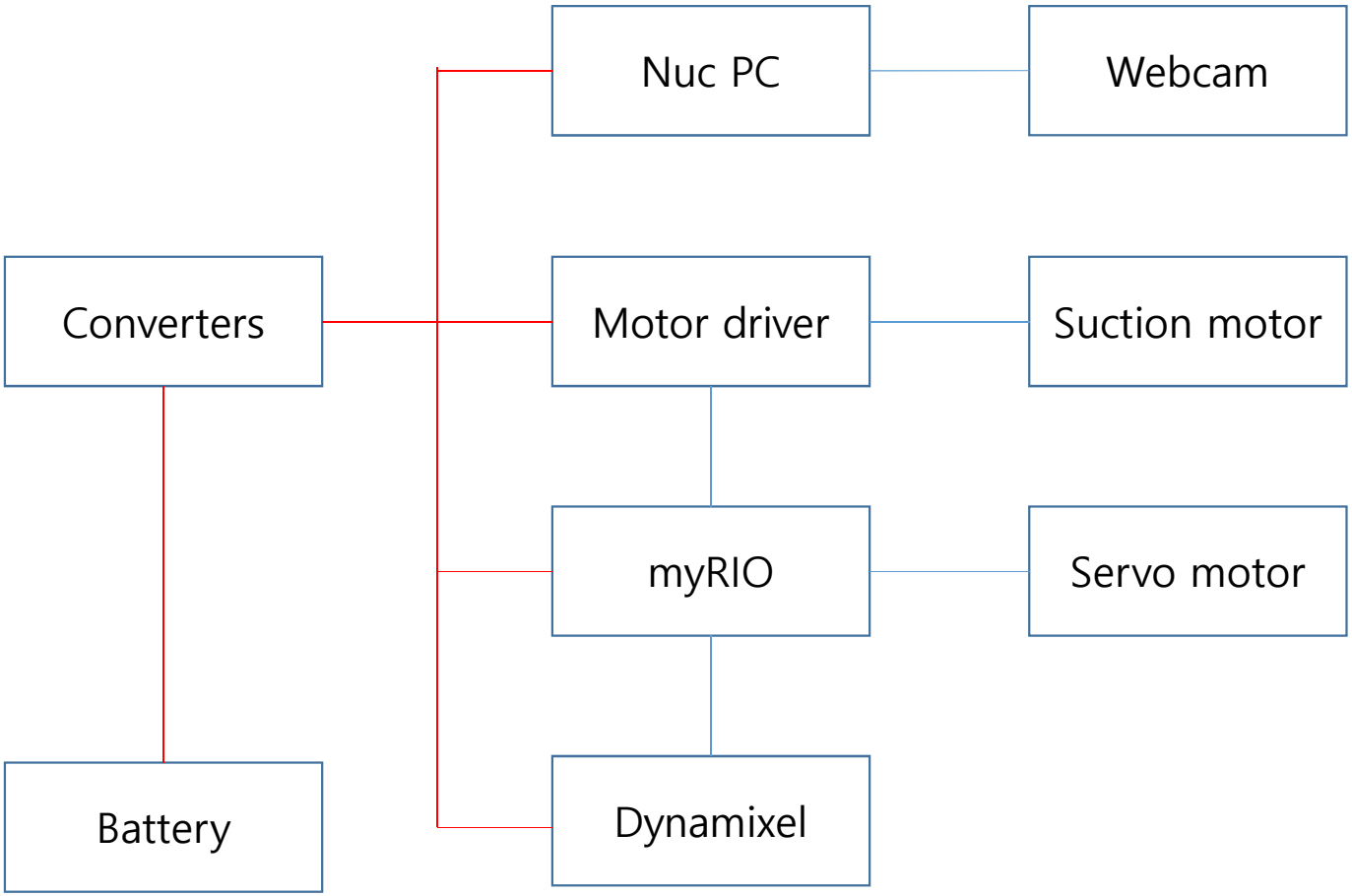




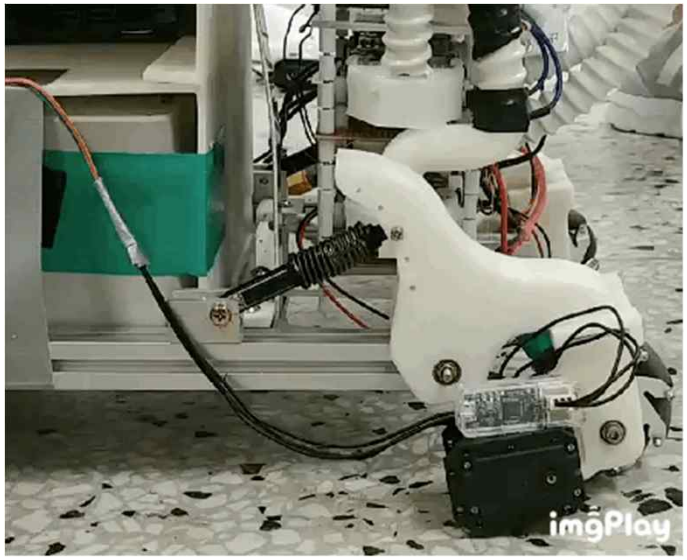
System Introduction

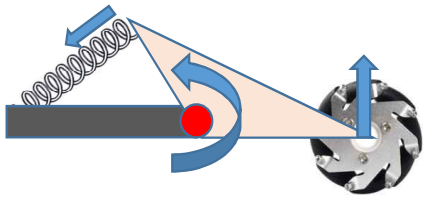


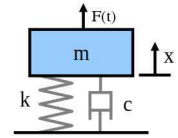
Hardware – Circuit



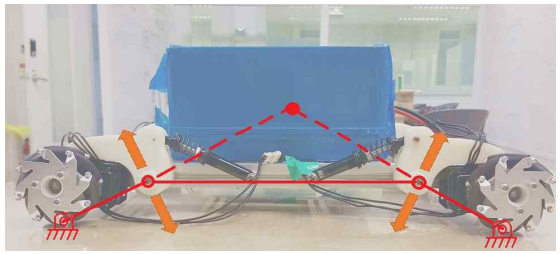
Hardware – Suspension



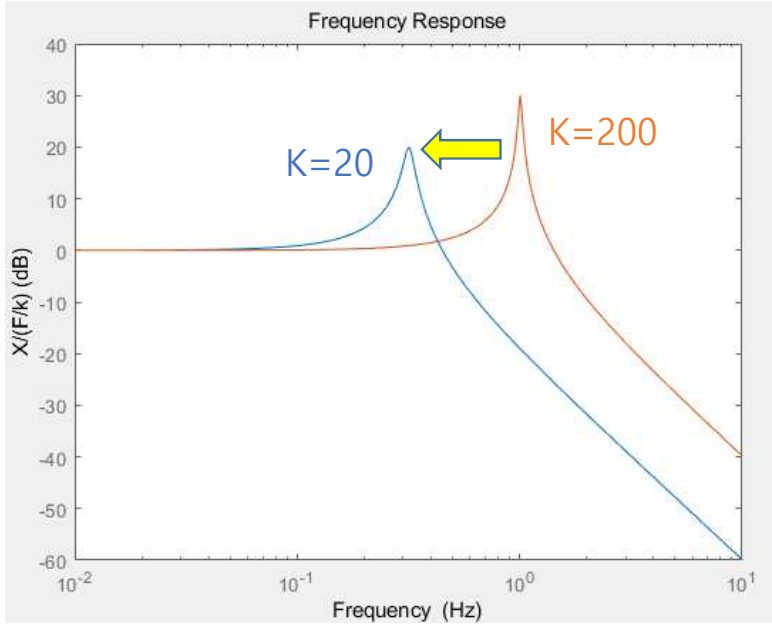




$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F(t)$$



1. Reduce Vibration



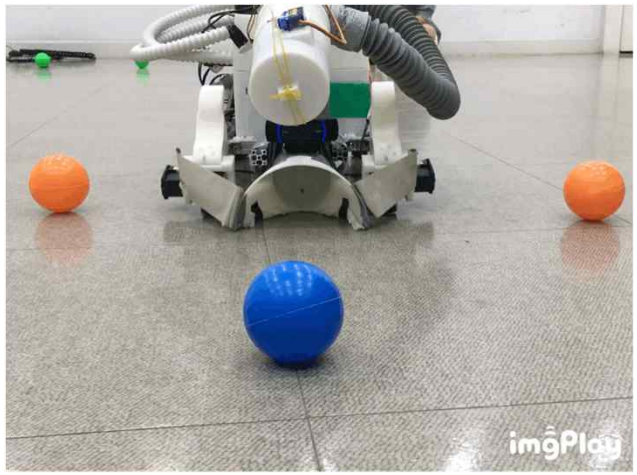
- High frequency vibration
  ->vision problem
- With smaller K, less vibration in high frequency region

2. Increase Traction

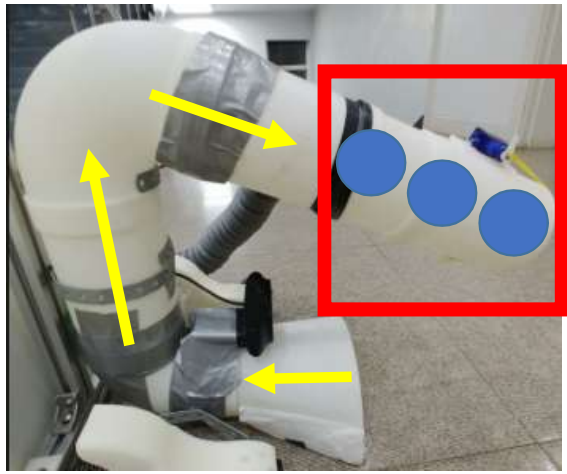
Without Suspension

With Suspension

Hardware - Suction Process



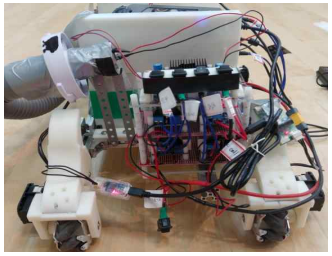
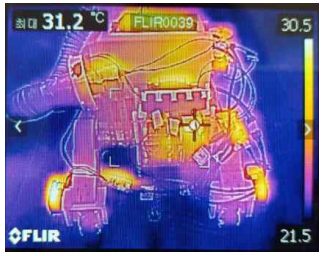
- Easy to collect balls

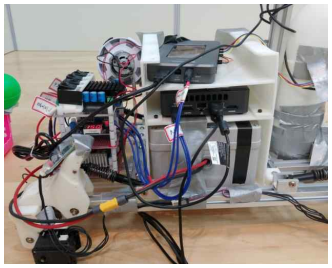


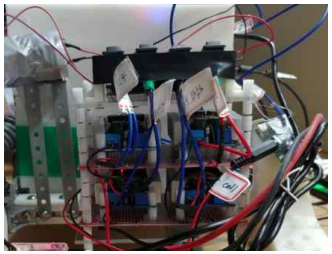
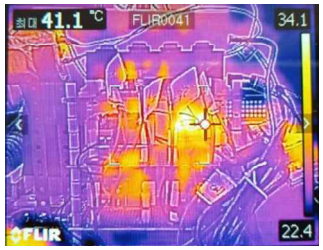
- Storage faces the front of the robot

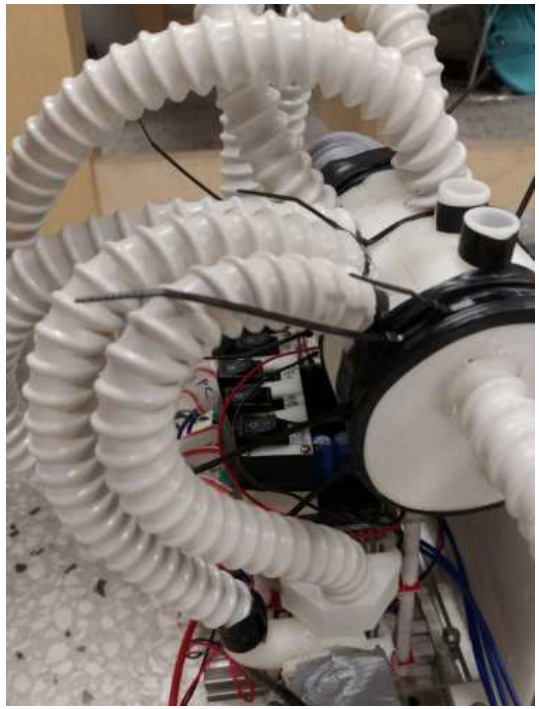
- Accurate because it uses camera vision
- Fast because it doesn't turn around

Hardware – Cooling





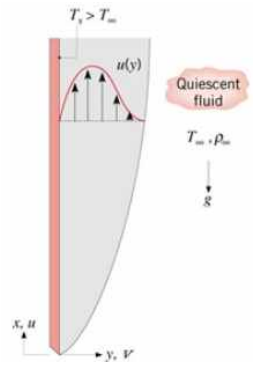
1. Free convection

$T_\infty = 20^\circ\mathrm{C},\ T_s = 40^\circ C,\ L = 0.05\mathrm{m}$

$$Ra_L = \frac{g\beta(T_s - T_\infty)L^3}{\nu\alpha} = 2.1796\times10^5$$

$$\overline{Nu_L} = 0.59 Ra_L^{\frac{1}{4}} = 12.7481$$

$$\therefore \bar{h} = \frac{\overline{Nu_D}k}{L} = \boxed{6.7565\ \mathrm{W/m^2K}}$$



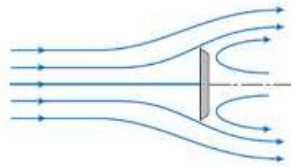
2. Forced convection

$T_\infty = 20^\circ\mathrm{C},\ T_s = 40^\circ C,\ D = 0.05\mathrm{m}$

$$\mathrm{Re}_D = \frac{VD}{\nu} = 9259$$

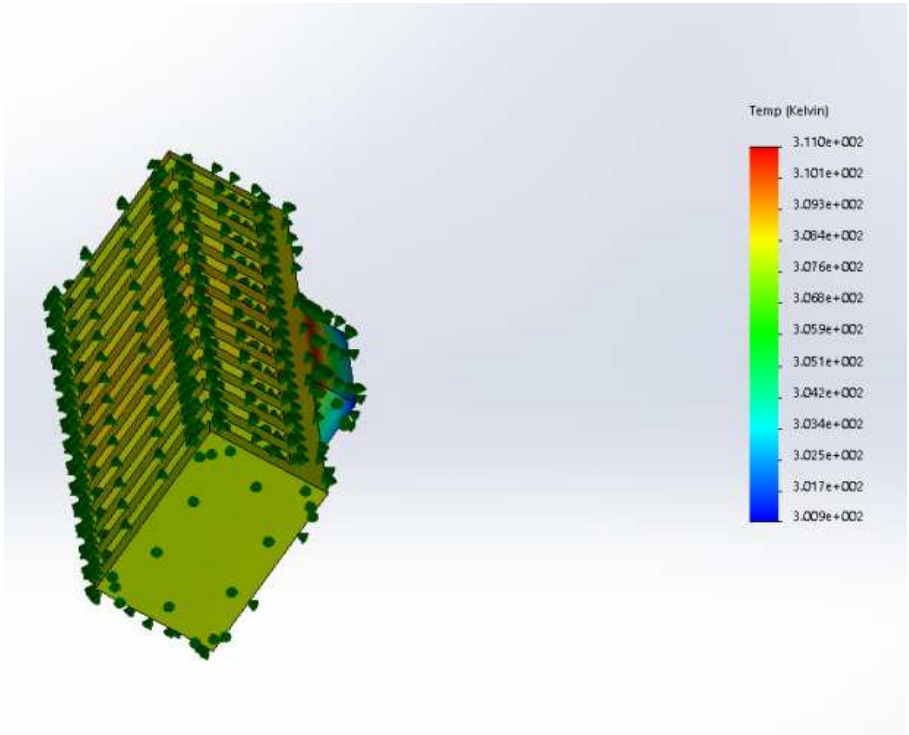
$$\overline{Nu_D} = 0.191\,\mathrm{Re}_D^{\frac{2}{3}}\,\mathrm{Pr}^{\frac{1}{3}} = 75.1$$

$$\therefore \bar{h} = \frac{\overline{Nu_D}k}{D} = \boxed{39.8\ \mathrm{W/m^2K}}$$

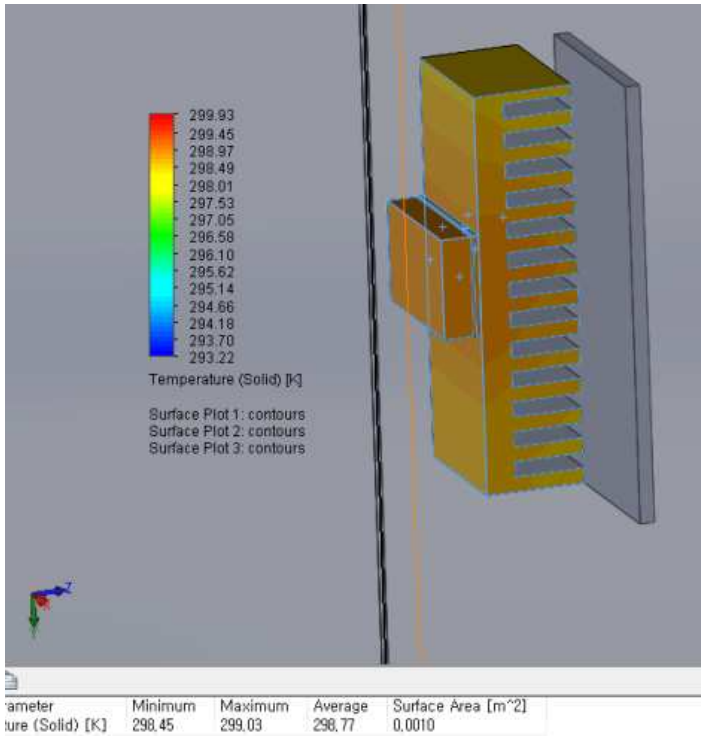


Hardware – Cooling

- Without Cooling ($T_{m\ ax} = 38℃$)

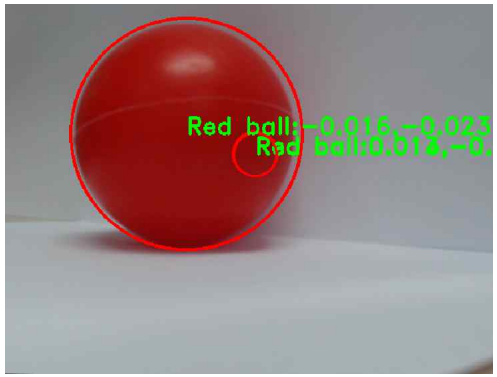


- With Cooling ($T_{m\ ax} = 26℃$)



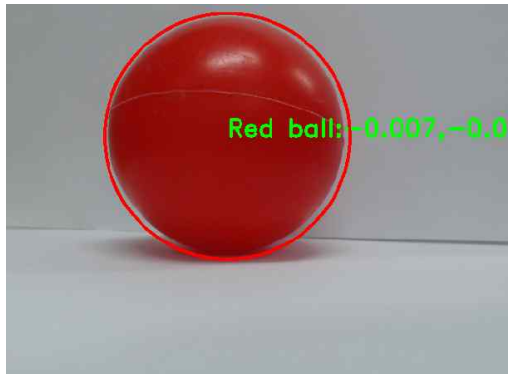
Software – Vision

```
Point2f one, two;
float x1, x2, y1, y2;
float r1, r2;
float l;

size_t contour_b = contours_b.size();
for( size_t i = 0; i< contour_b; i++ ){
            if(radius_b[i] > iMin_tracking_ball_size){
                for(size_t j=0; j<contour_b; j++){
                    for(size_t k=0; k<contour_b; k++){
                        one = center_b[j]; two = center_b[k];
                        r1 = radius_b[j];  r2 = radius_b[k];

                        x1 = one.x; y1 = one.y;
                        x2 = two.x; y2 = two.y;
                         l = sqrt((x1-x2)*(x1-x2)+(y1-y2)*(y1-y2));

                        if(r1+r2>l){
                            if(r1>r2){ //!!!
                                radius_b.erase(radius_b.begin()+k);
                                center_b.erase(center_b.begin()+k);
                                contours_b.erase(contours_b.begin()+k);
                                contour_b--;
                                j--;
```



Contour_size=3

After erasing



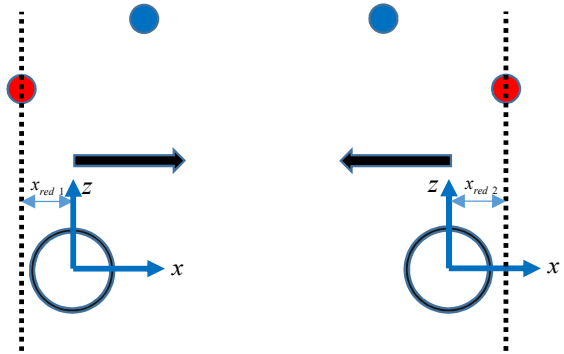
Contour_size=1

- Remove extra contour circle data with vector.erase function

Software – Algorithm

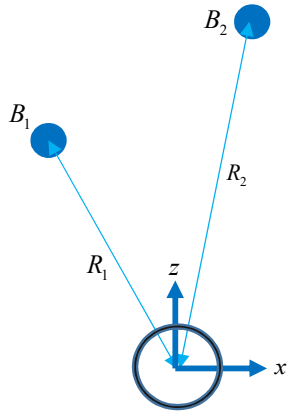
- When there is a red ball

If $|x_{red}| < x_s$,
move right or left !



- When there are several blue balls

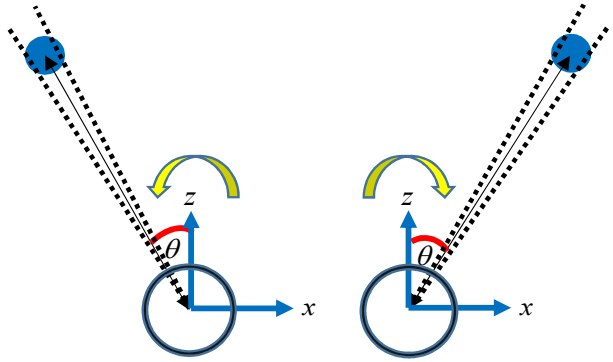
If $R_1 < R_2$,
we make B_1 target !



If Ball<3

- How to go to target ball

If $|\theta| > \theta_{band}$,
turn CW or CCW !
If $|\theta| \le \theta_{band}$,
go straight !

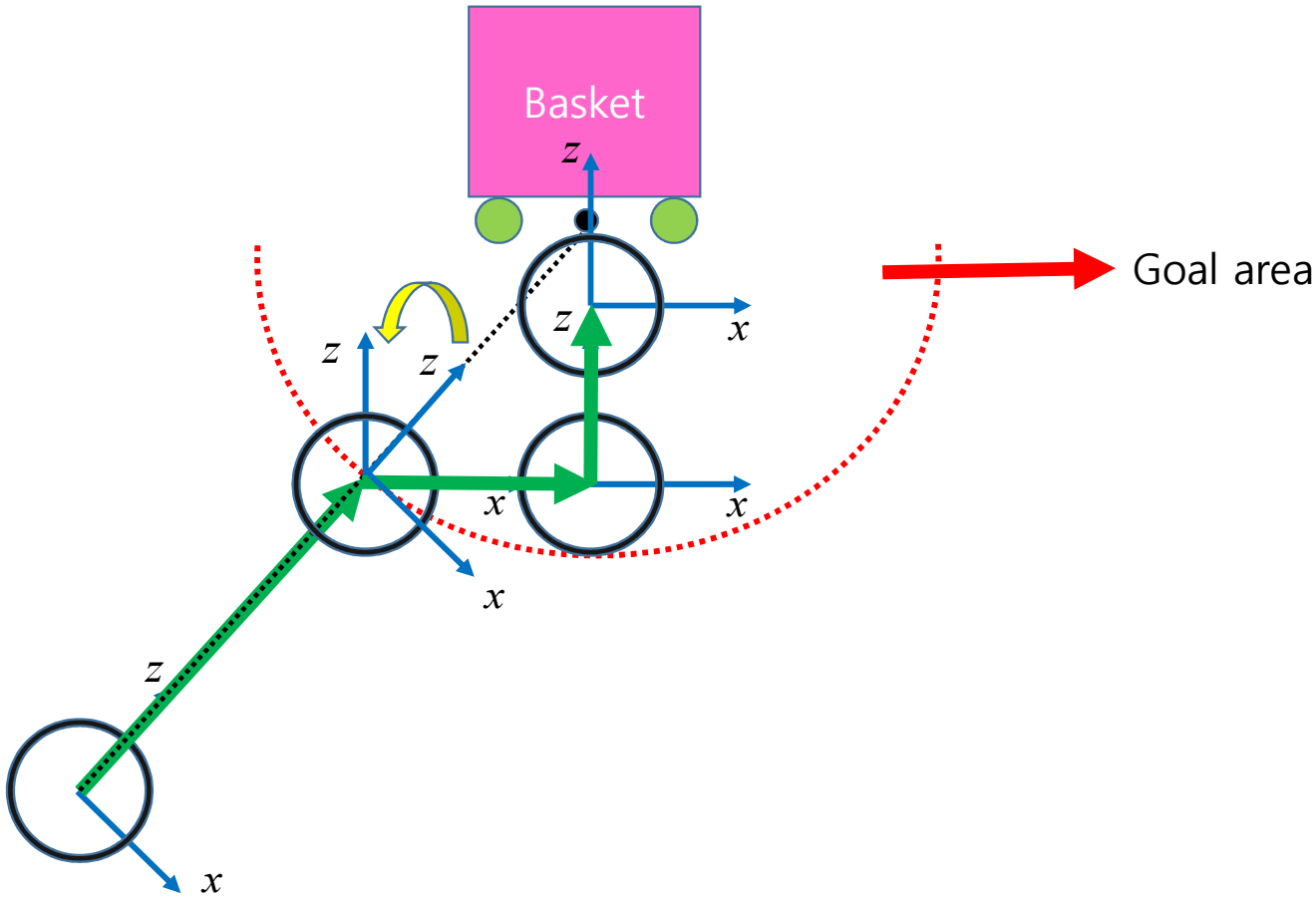


If Ball=3

Go back to Basket

Software – Algorithm

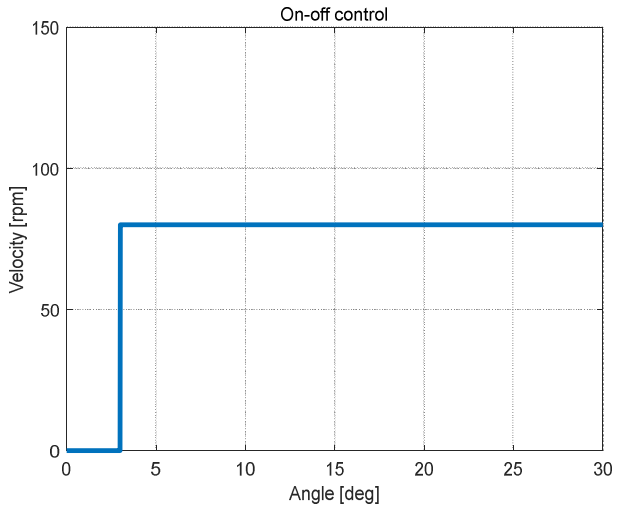
- How to go back to the basket



Software - PD control

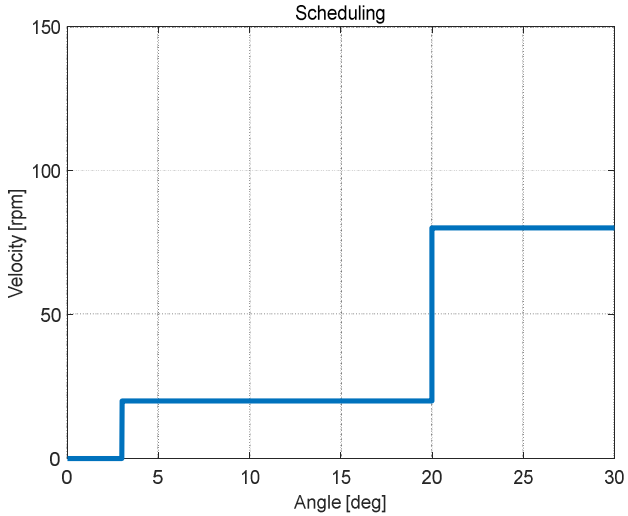
- Robot Direction control using feedback control

Bang-bang Control (On-off Control)



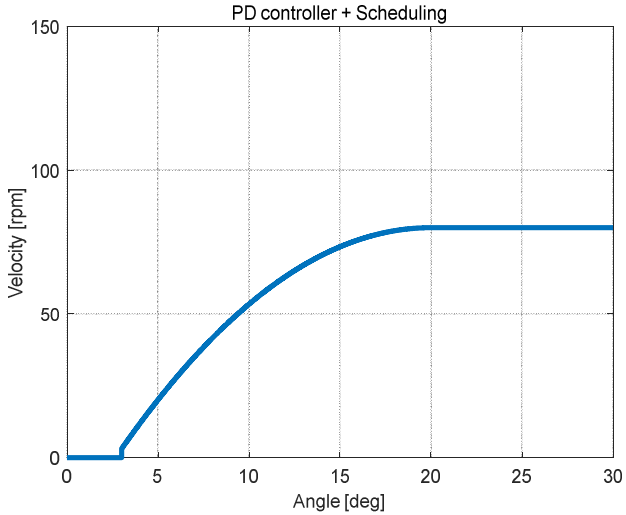
- Error due to deceleration time
- Jerk due to discontinuous velocity profile

Scheduling (Open Loop)



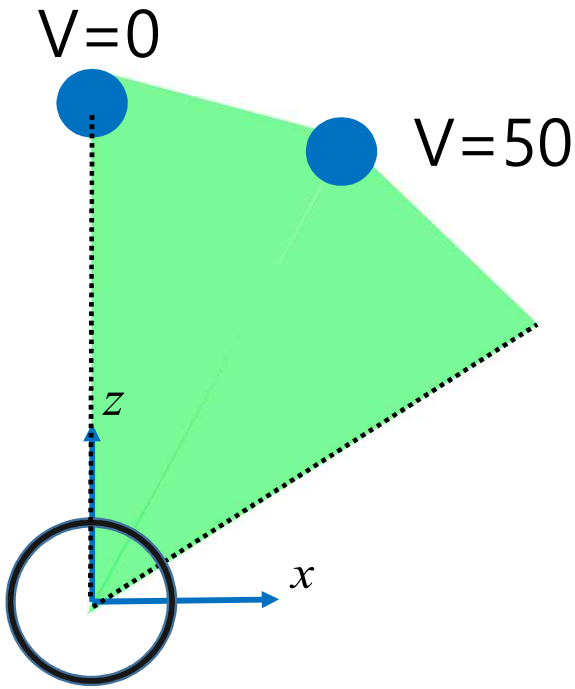
- Reduced error and Jerk
- Open loop control

PD Control (Closed Loop)



- Even less error and Jerk
- Robust due to closed loop control

Software - Bang-bang control



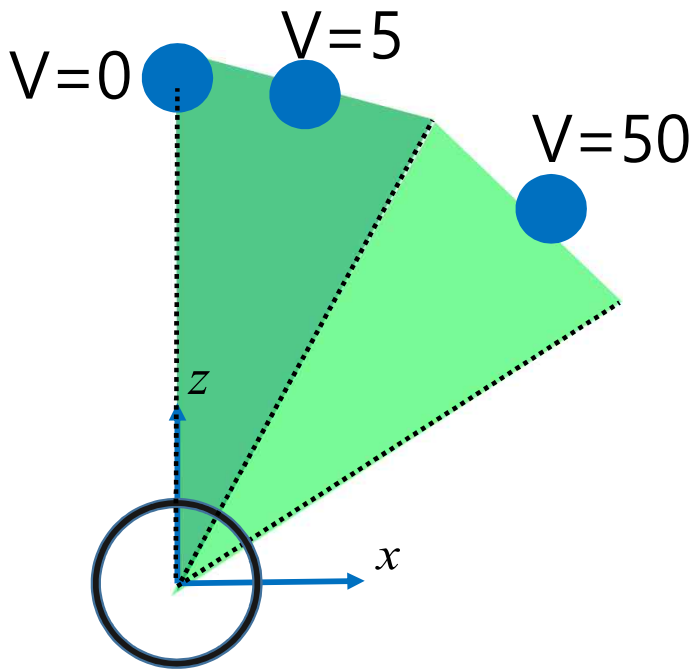
Software - Scheduling

On-off control

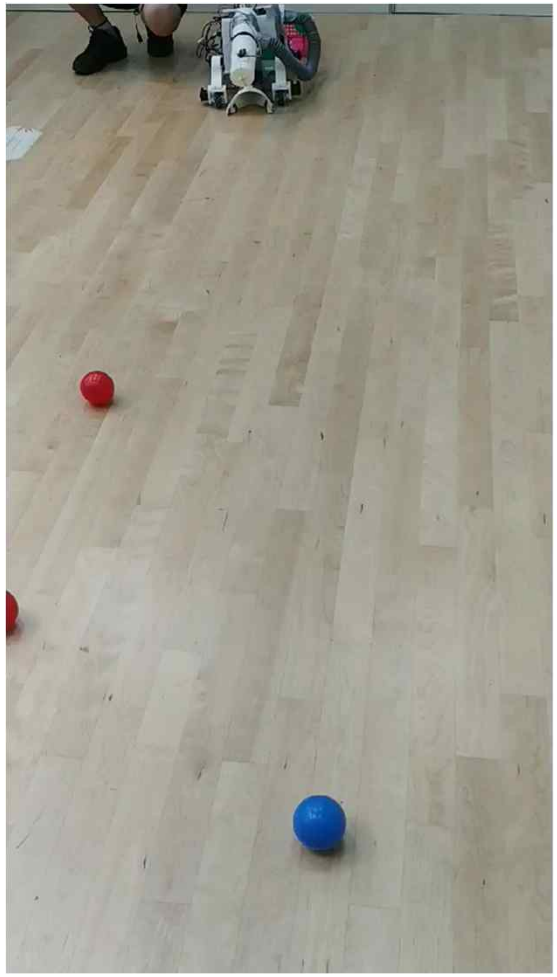
- Fast speed -> more error
- Slow speed -> more time

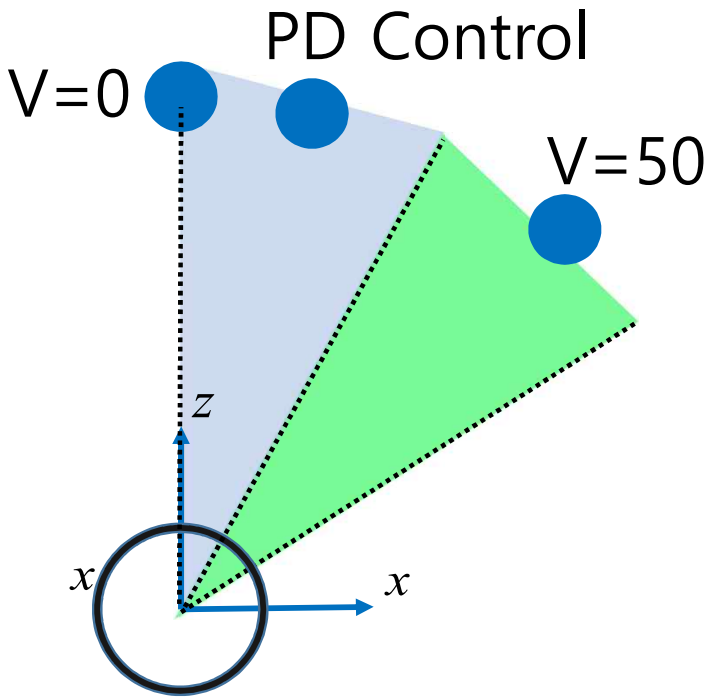
Scheduling

- Slow speed when angle is small
  ->reduce error
- Fast speed when angle is big
  ->reduce time

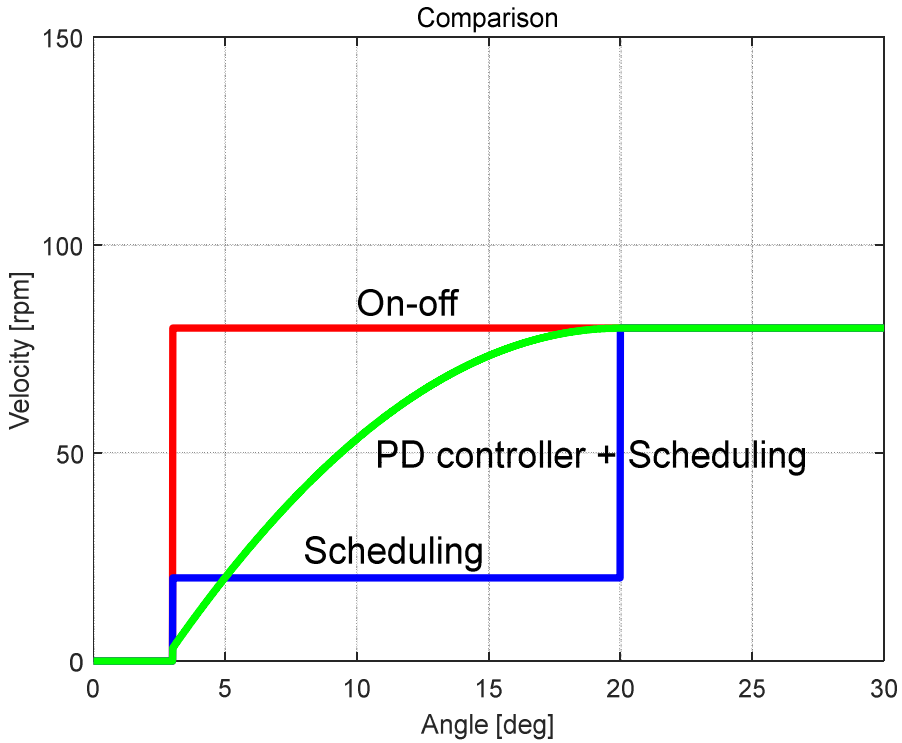


Software - Scheduling -〉PD control





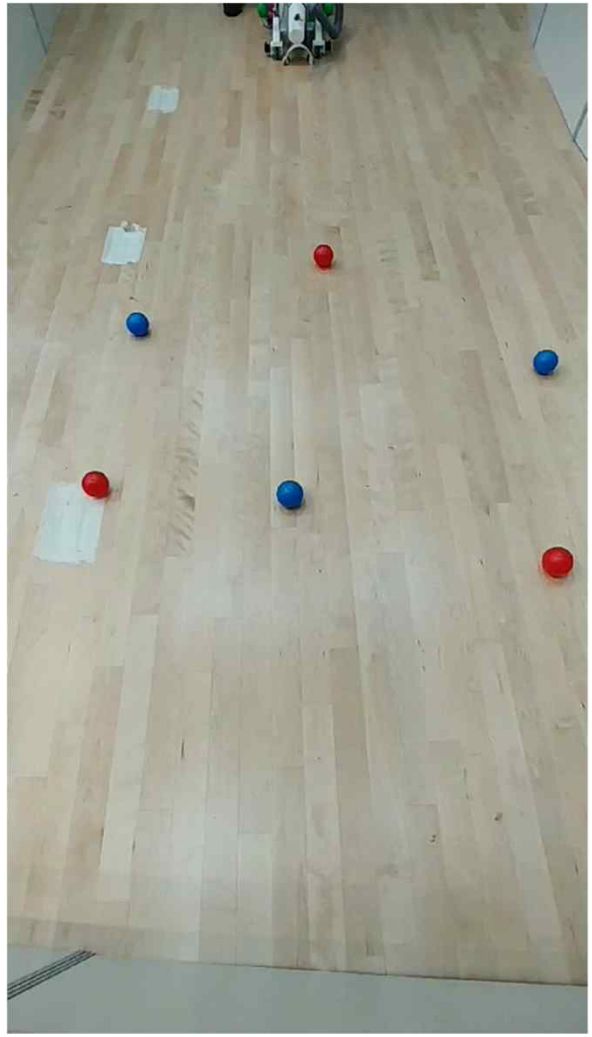
Software - PD control



Advantage of Feedback control : Robustness

- Uneven floor
- Deformation of Hardware
- External disturbances

Demo Video (x2)



Thank you