ROLLING BALL COLLECTOR

CAPSTONE DESIGN 1ST PRESENTATION

Advisor: Prof. YongHwa Park
TA: Sooyong Kim
Team Member : Sangwon Yoon, Duckyoung Kim, Minkyung Kim, Won Choi, Yechan Lee, Sungwoog Hong, Cheol Sagong

CONTENTS

PROBLEM DEFINITION

- Common mission
- Function Analysis
- Define Unknowns

CONCEPT

- Concept Overview
- Pick up
- Heat Transfer & Vibration

OTHER WORKS

- Ros
- Open CV
- Labview

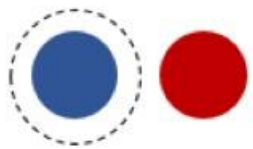
FUTURE WORKS

- Unsolved Problems
- Next Goals

PROBLEM DEFINITION

Specify given problems and set the plan for the approach

COMMON MISSION

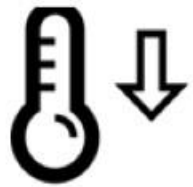


DISTINGUISH

- Algorithm for exact mapping

< 5MIN

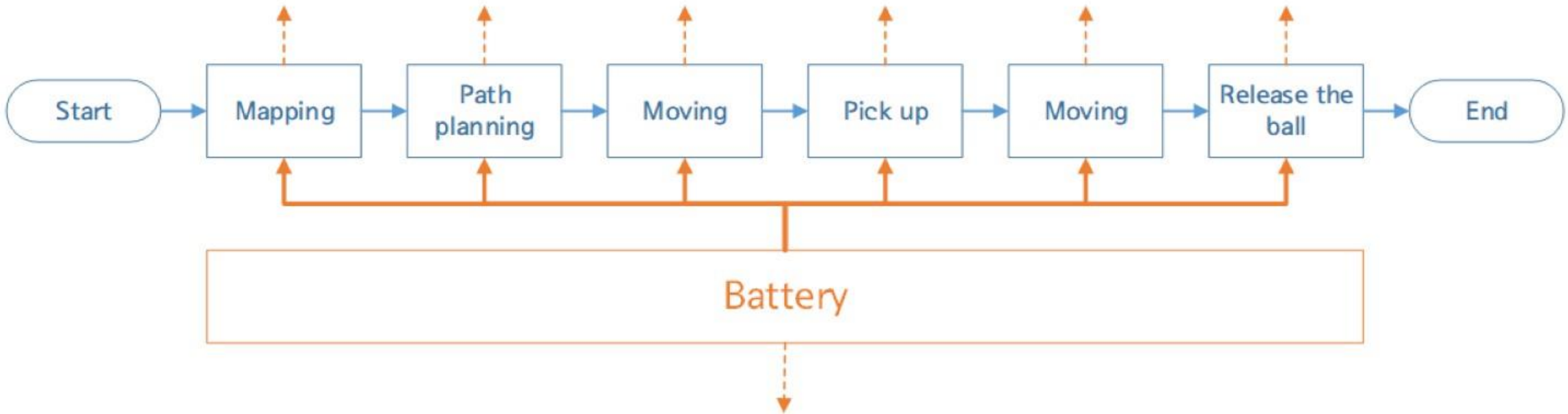
- Plan for the shortest route
- Effective pick up method



COOLING

- Effective Heat transfer
- Minimize battery consumption

FUNCTION ANALYSIS

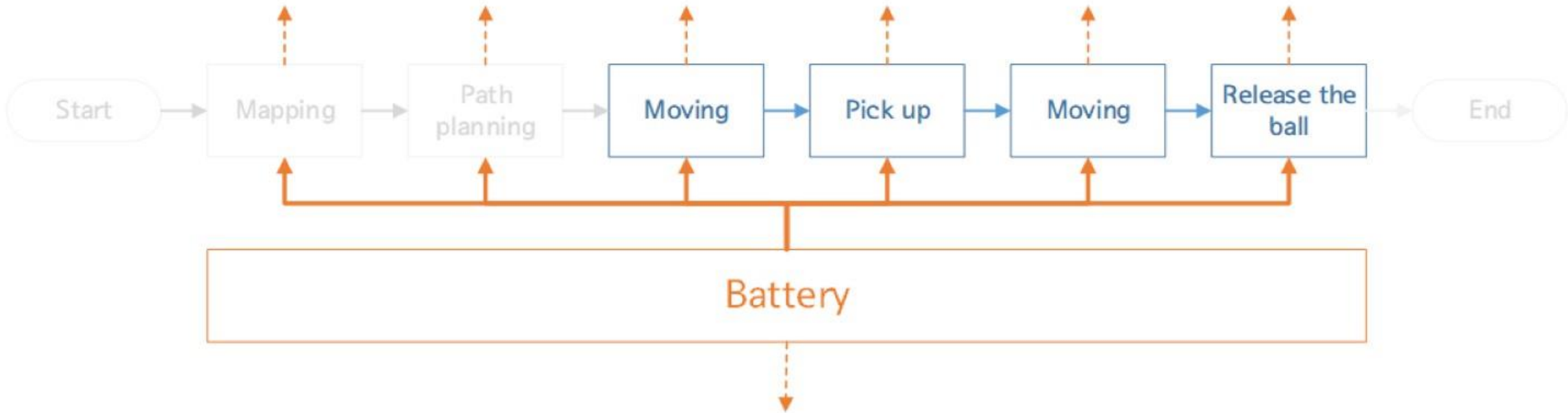


Information Flow

Energy Flow

Energy Dissipation

FUNCTION ANALYSIS



Information Flow

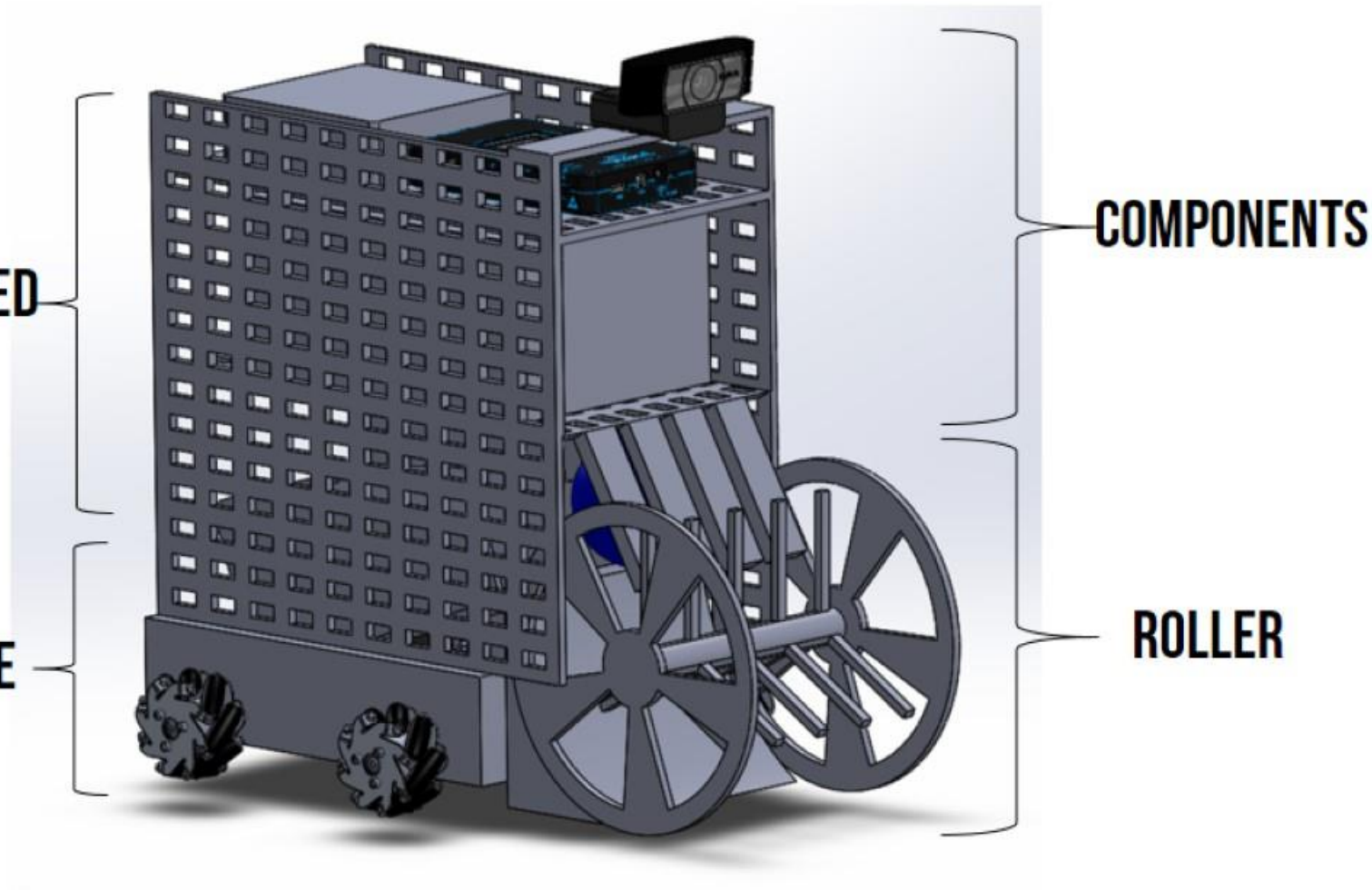
Energy Flow

Energy Dissipation

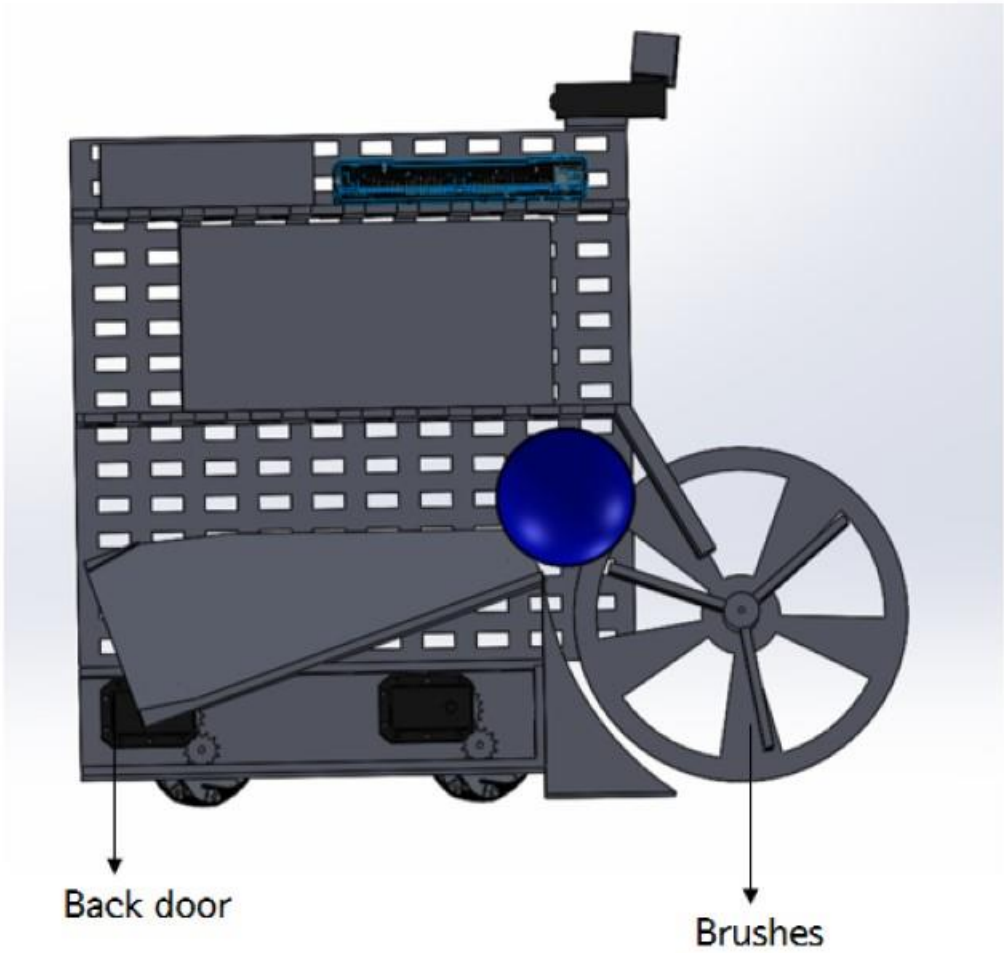
CONCEPT

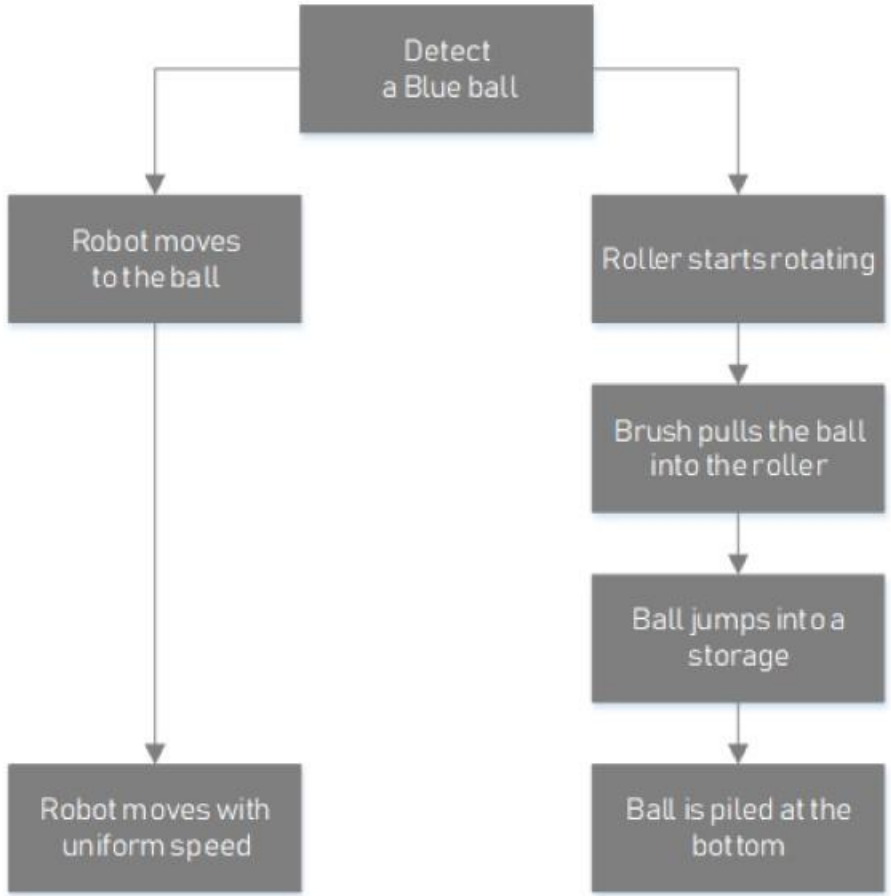
Ideation result for the pickup, heat transfer, and vibration

CONCEPT OVERVIEW



PICK UP


Back door
Brushes


Detect
a Blue ball
Robot moves
to the ball
Roller starts rotating
Brush pulls the ball
into the roller
Ball jumps into a
storage
Ball is piled at the
bottom
Robot moves with
uniform speed

GOODS & BADS

GOODS

- Time effective
  - Catch the ball during the movement
- Ease of control
  - One additional motor required
- Ease of release

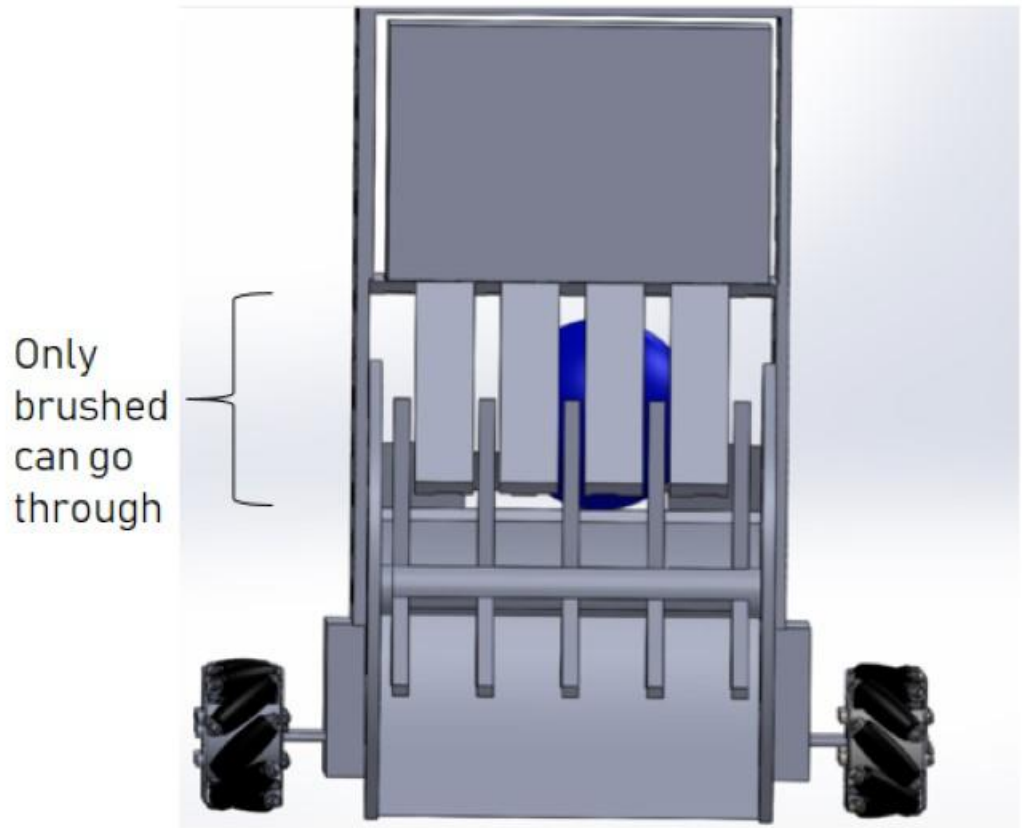
BADS

- Go in and Get out
- Possibilities of hit the ball
- Instability
  - Additional mass of roller, slide and a storage
  - Center of mass goes higher

SOLUTION

BADS

- Go in and Get out
- Possibilities of hit the ball
- Instability
  - Additional mass of roller, slide and a storage
  - Center of mass goes higher

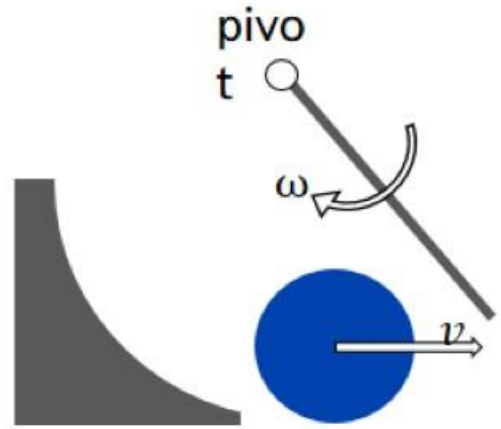


Segmentation *from TRIZ*

SOLUTION

BADS

- Go in and Get out
- Possibilities of hit the ball
- Instability
  - Additional mass of roller, slide and a storage
  - Center of mass goes higher



ω: angular velocity
v: Relative velocity of a ball relative to the mobile platform

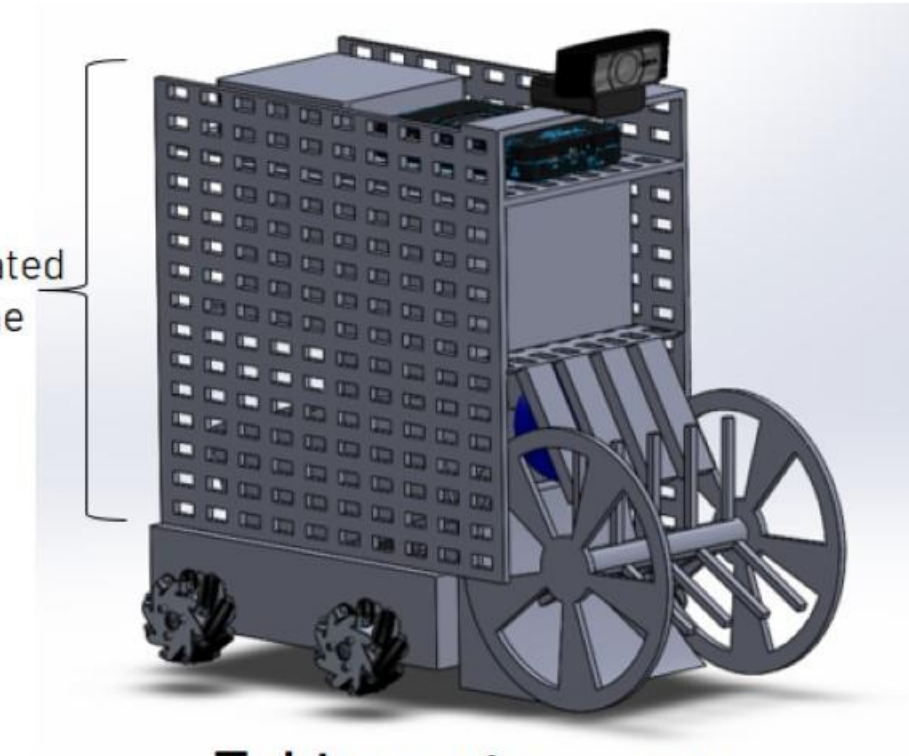
- Control ω relative to the v
- Find Optimal dimension:
  - -length of brush.
  - -the height of pivot
  - -the distance between platform body and pivot.

SOLUTION

BADS

- Go in and Get out
- Possibilities of hit the ball
- Instability
  - Additional mass of roller, slide and a storage
  - Center of mass goes higher

1) Additional mass



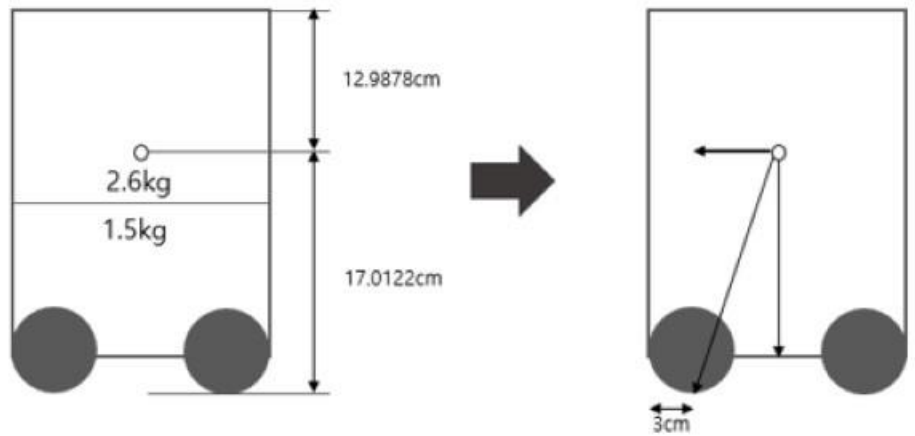
Taking out *from TRIZ*

SOLUTION

BADS

- Go in and Get out
- Possibilities of hit the ball
- Instability
  - Additional mass of roller, slide and a storage
  - Center of mass goes higher

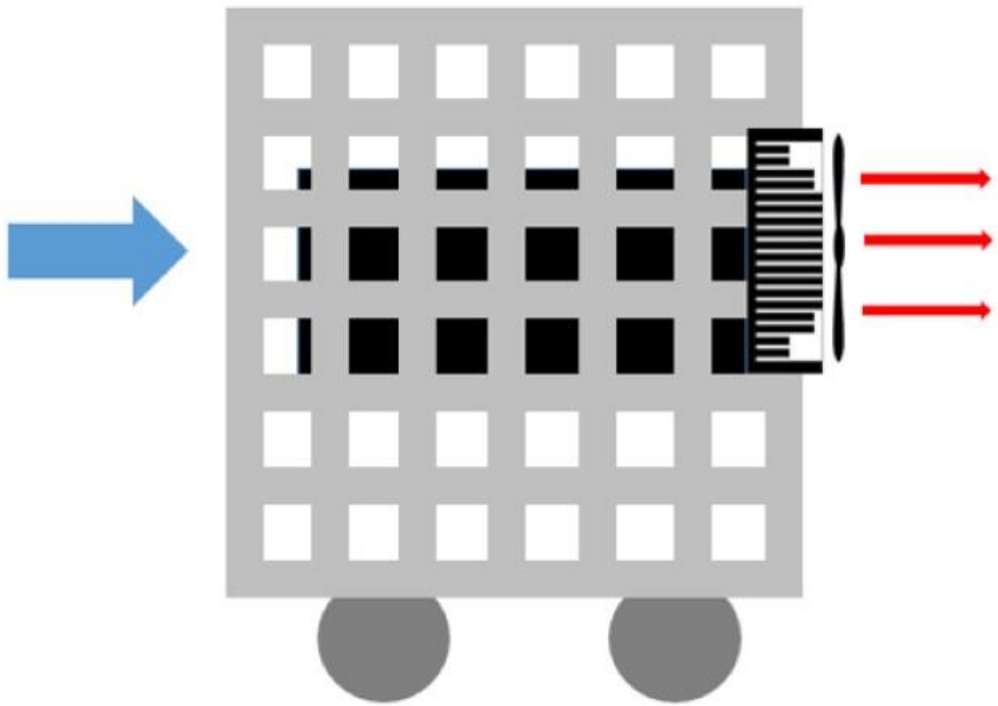
2) COM goes higher



Allowable least acceleration: 4.032m/s²

Max. Acceleration of the wheel: 27.38 m/s²

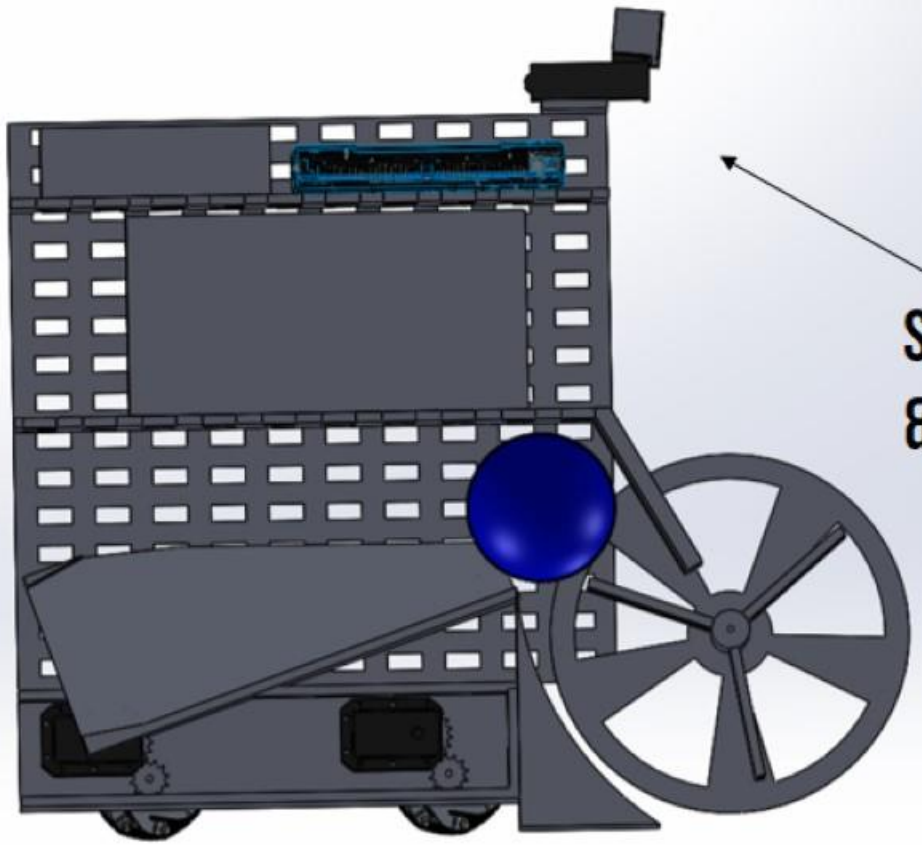
HEAT TRANSFER



STRATEGY

- Minimize Energy usage
  - Optimal path planning
  - Light weight
  - Rotating roller only for the pick up process
- Increase Surface area
  - Perforated Frame with high conductivity
- Heat Sink and Cooling Fan
  - Maximize air flow

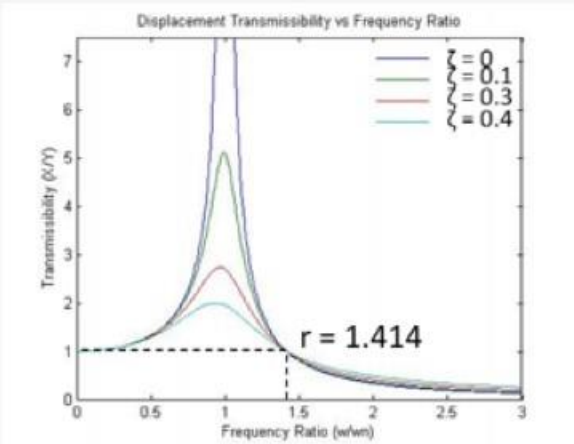
VIBRATION



SPRING
&DAMPER

STRATEGY

- Absorb vibration only for the cam, rather than the whole system

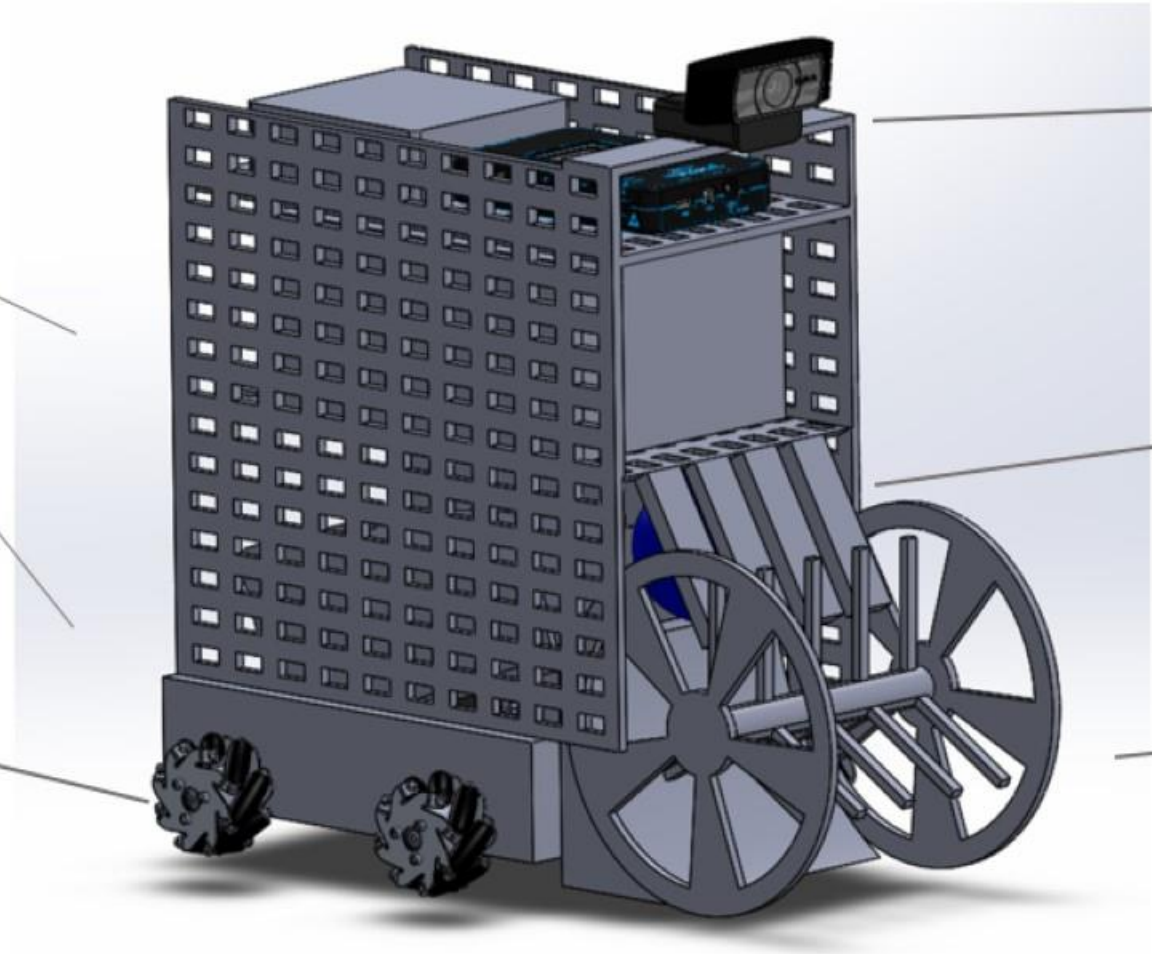


- Make high frequency ratio(>√2) & low damping ratio

SUMMARY

Hole to help cooling and reduce weight

Control the acceleration to avoid the flip



Dynamic Vibration Absorber

Prevent ball from escaping

Appropriate roller speed to avoid collision

OTHER WORKS

Brief summary for the progress of ROS, Open CV, and Labview

ROS

TOPIC

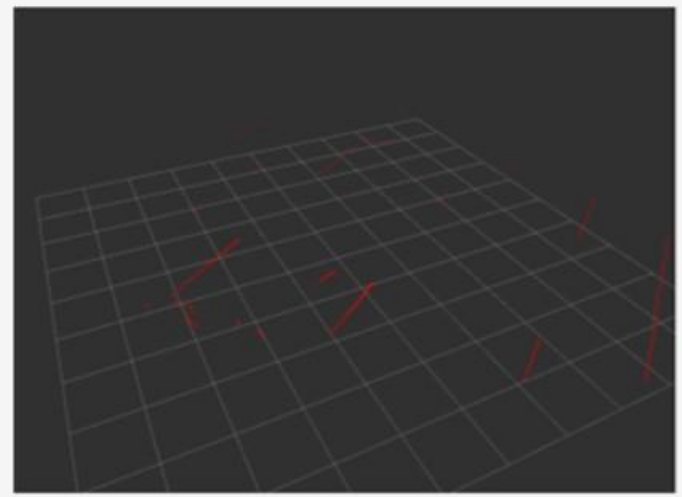
- Continuous communication which is used to send and receive the data
- Get the distance data and send it to myRIO to control the velocity

SERVICE

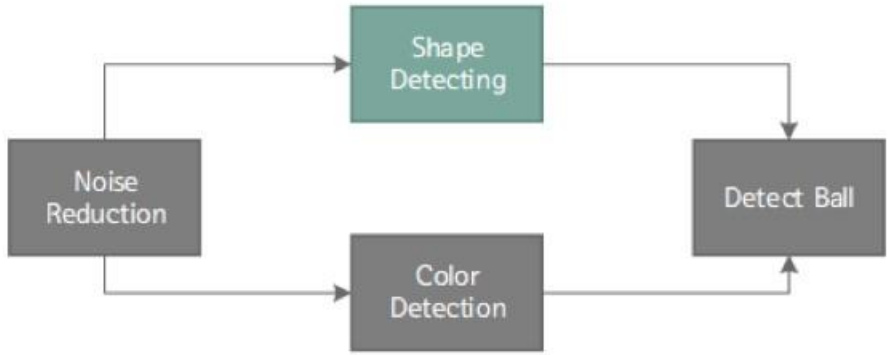
- Sporadic communication ordering for the specific event
- Used for changing the direction and avoiding obstacles

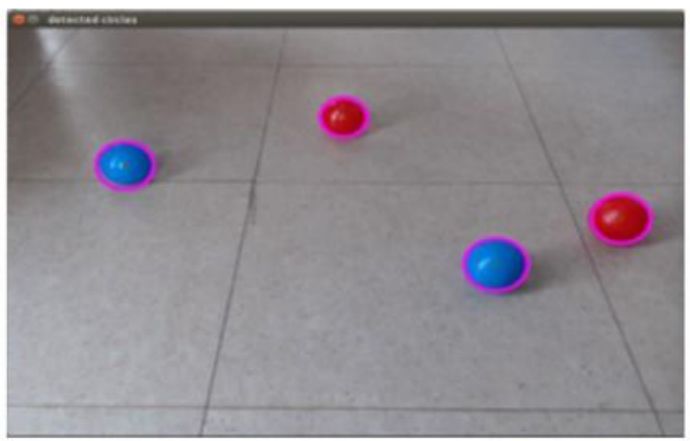
RVIZ

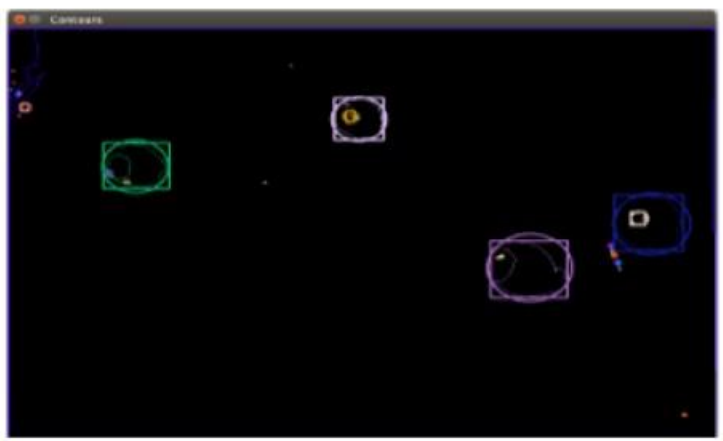
- Visualize of LIDAR /cam data



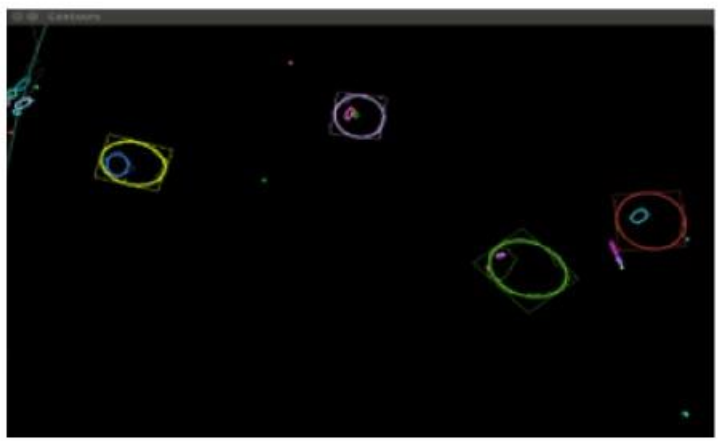
CURRENT PROGRESS (2) OPEN CV







(a) Creating Bounding boxes and circles for contours



(b) Creating Bounding rotated boxes and ellipses for contours

CURRENT PROGRESS (3) LABVIEW

Wheel & Position mode control

TCP/IP

SERIAL

COMPUTER

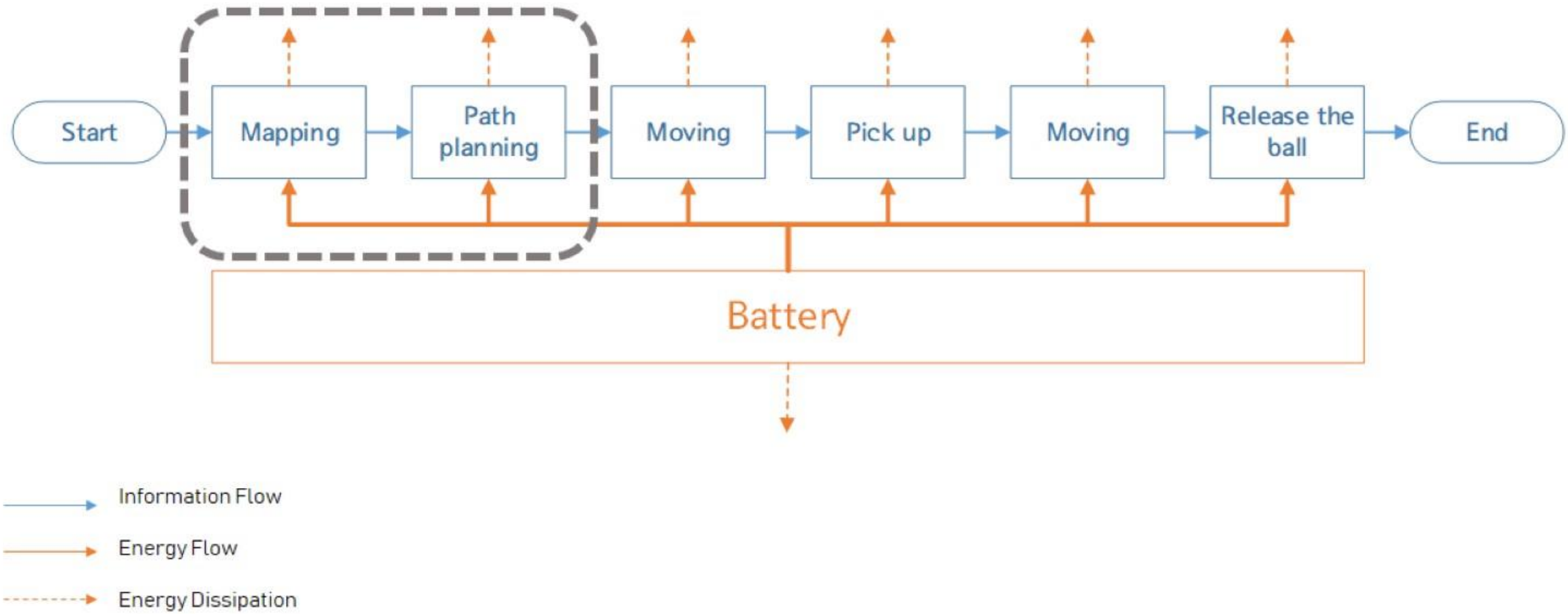
MYRIO

DYNAMIXEL

FUTURE WORKS

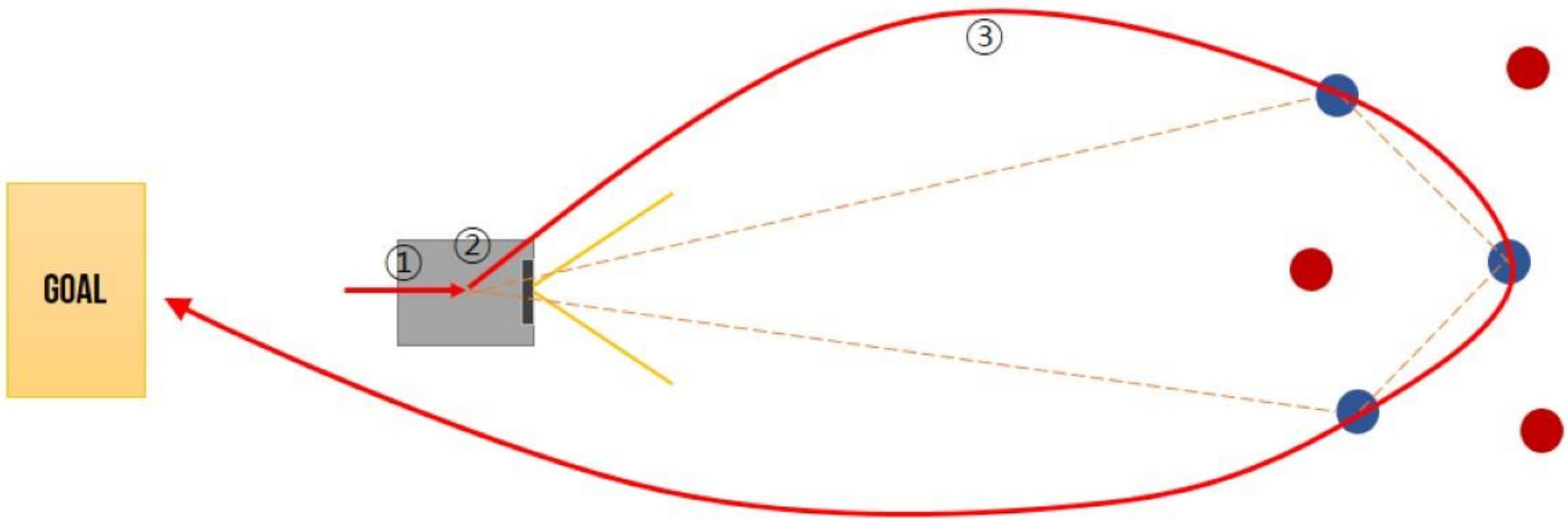
Overall summary for the system and next goal

FUNCTION ANALYSIS



PATH GENERATION

We can find an optimal path because our robot collect balls while moving



① MAPPING

② CALCULATE OPTIMAL PATH

③ MOVE WITH VISUAL FEEDBACK
(DECREASING ERRORS)

NEXT GOALS

ROS

- Get the information from webcam and transfer to myRIO
- Motor control using Xbox
- Based on the webcam, find the optimal route

OPEN CV

- Find proper ball tracking method at various condition
- 3D mapping
- Combine mapping data with Lidar

LABVIEW

- Mecanum wheels control
  - Straigh movement
  - Rotation
- Roller motor control
- Backdoor open system

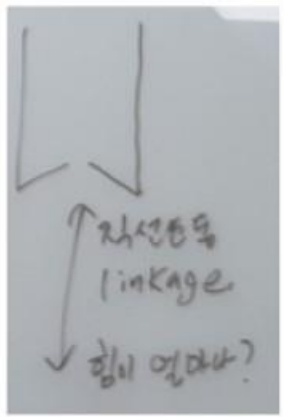
Q&A

REFERENCE

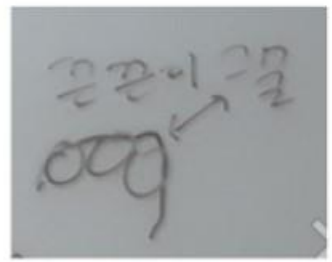
BRAINSTORMING

1. 격자형 집게

2. W자형 집게



3. 끈끈이



4. 지게차

4. 우선 다 담고 골라내기 (깔때기 형)

6. 빨간공 쳐내기

7. 바구니를 끌고가기

8. 벽으로 밀어서 일렬로 만들기

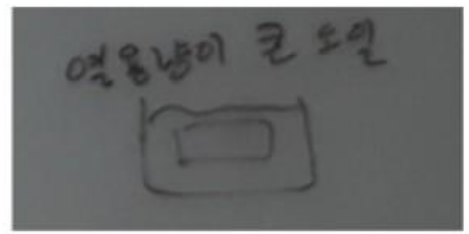
9. 바구니까지 이어지는 통로

BRAINSTORMING

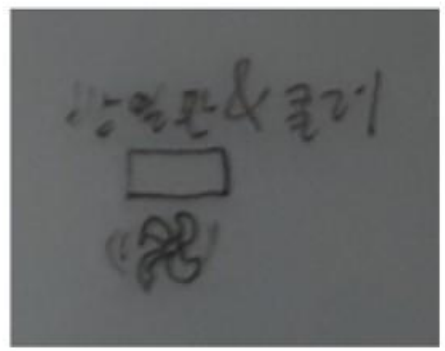
1. 드라이아이스
(혹은 다른 냉매)

2. Pms 위아래로 공간을 두어 이동을 이용하여 convection

3. 열용량이 큰 오일에 담그기



3. 방열판과 쿨러



DECISION MATRIX (1) PICK UP

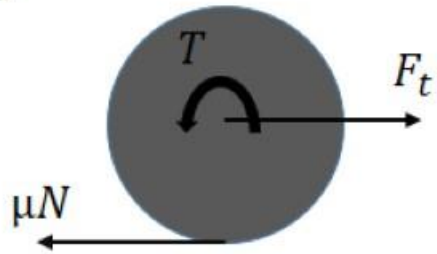
Issue: Choose the most efficient pick up method		Baseline :기계팔 집기	눌러서 잡기	꼰꼰이	지게차	빨아들이기	돌려	슬어담기
정확도	26	0	1	1	0	0	1	1
집는 시간	18	0	1	1	1	0	1	1
복구 가능성	8	0	0	0	0	0	0	0
크기:다른공칠수도	14	0	0	0	-1	0	-1	-1
제작편의성	26	0	1	1	1	0	1	1
에너지 소모	8	0	1	1	1	-1	1	0
		0	78	78	38	-8	64	56

DECISION MATRIX (1) PICK UP

Issue: Choose the most efficient pick up method		눌러서 잡기	꼰꼰이	롤러	쓸어담기
정확도	26	0.74	0.66	0.82	0.56
집는 시간	18	0.82	0.8	0.9	0.8
복구 가능성	8	0	0	0.32	0.5
크기:다른공칠수도	14	0.7	0.7	0.44	0.56
제작편의성	26	0.66	0.66	0.67	0.7
에너지 소모	8	0.74	0.8	0.56	0.46
		66.88	64.92	68.14	62.68

DYNAMIC INTERPRETATION

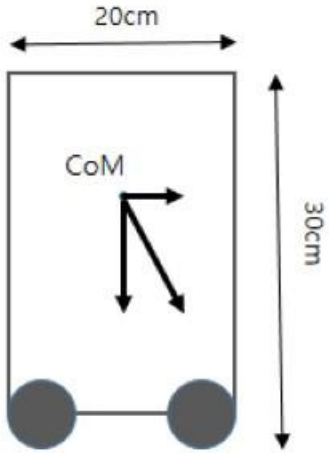
1.



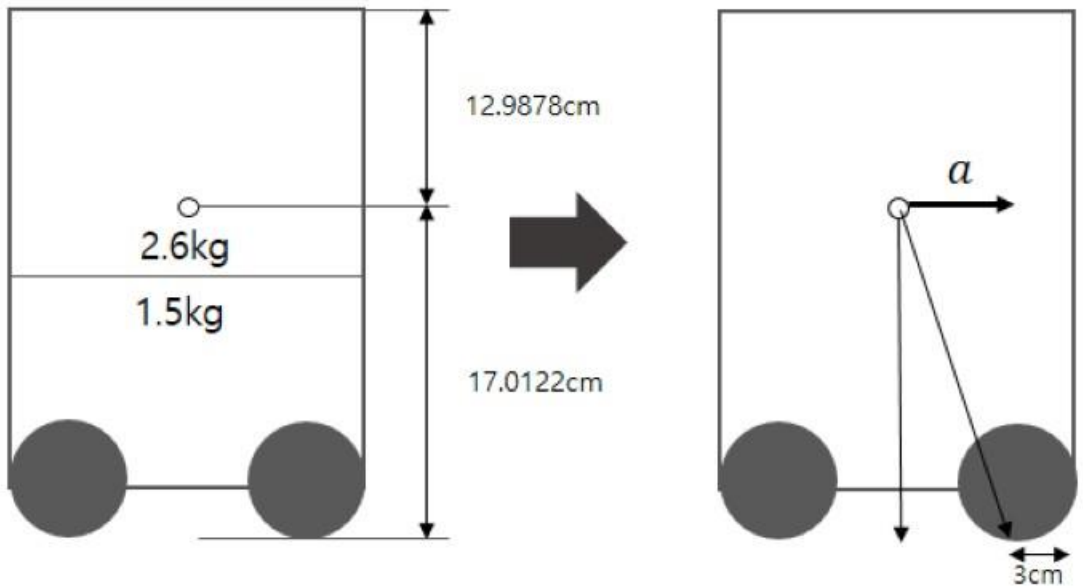
$$Ma = 4F_t$$
$$T - \mu Nr = \frac{1}{2}mra$$
$$T = \frac{3}{2}mra + \frac{1}{4}Mra$$
$$a = \frac{T}{3mr/_2 + Mr/_4}$$

$max\ T$ is given (motor spec, 2.3Nm)
Find the maximum acceleration with respect to given T by this equation.

$Maximum\ a$: 27.38m/s²



2.

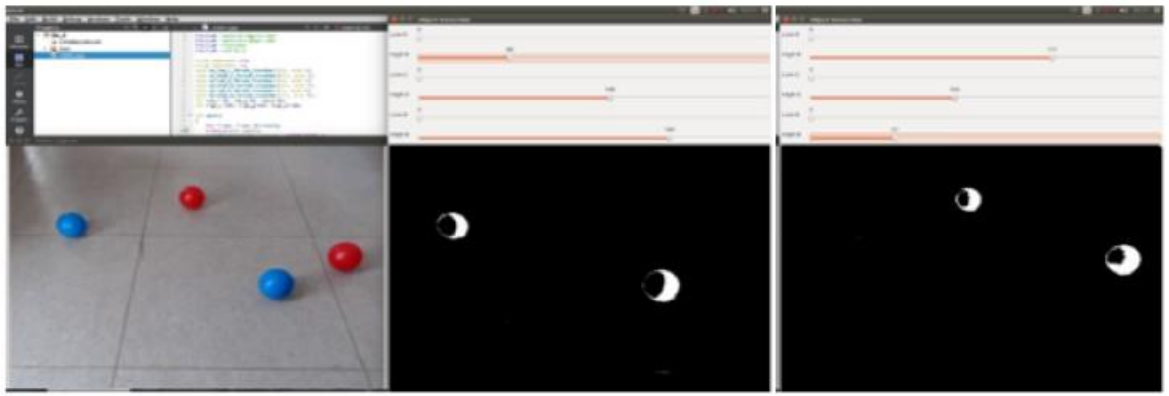


$$a : g = 7 : 17.0122$$
$$\therefore a = 4.032 m/s^2$$

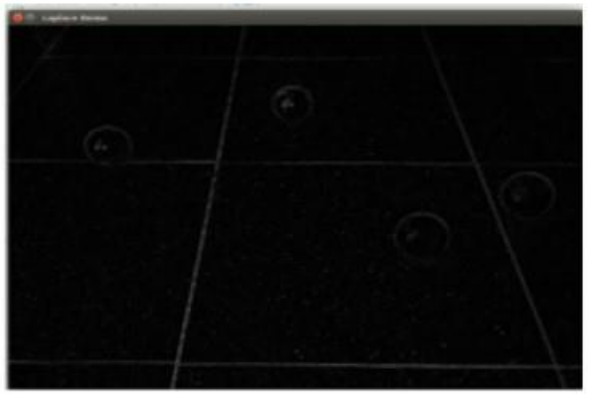
In our model, mass and geometry is shown in figure(2).

In geometry, vector sum of g and platform's acceleration must do not exceed the contact point of the wheel and ground

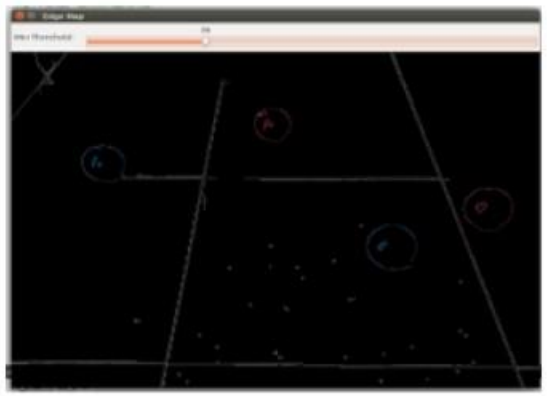
BALL DETECTING DETAIL



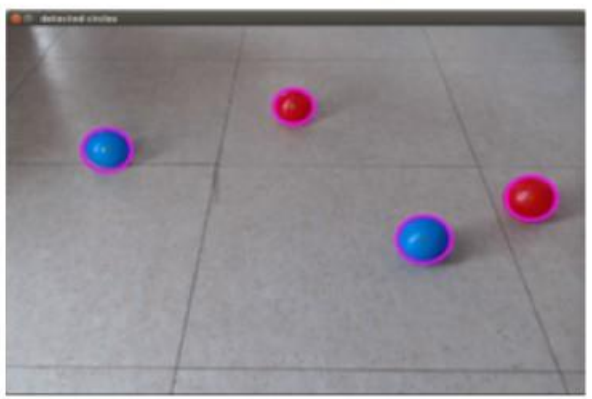
(a) Thresholding Operation



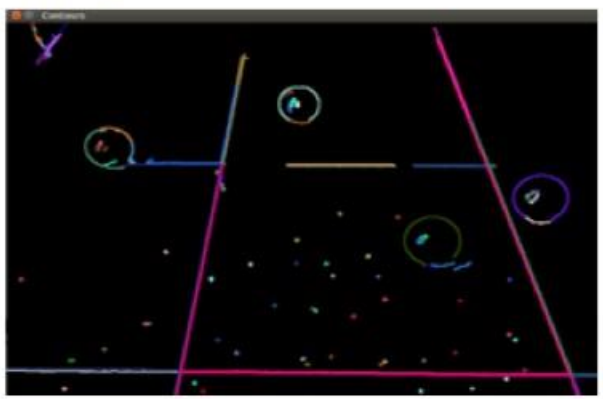
(b) Laplace Operation



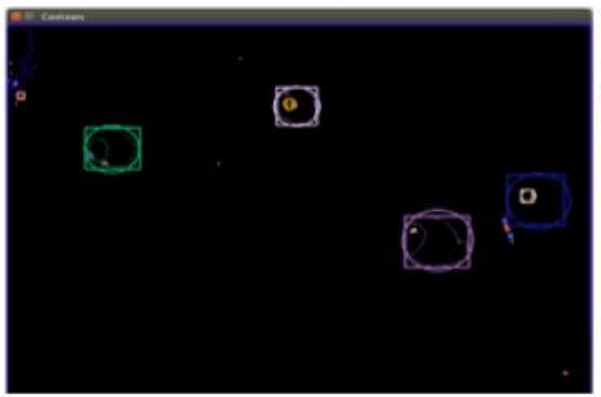
(c) Canny Edge Detector



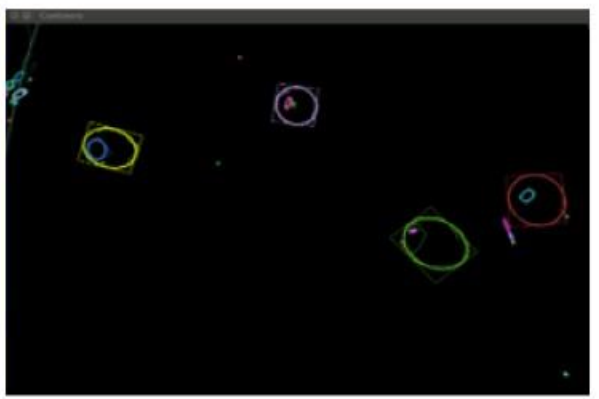
(d) Hough Circle Transform



(e) Find Contour



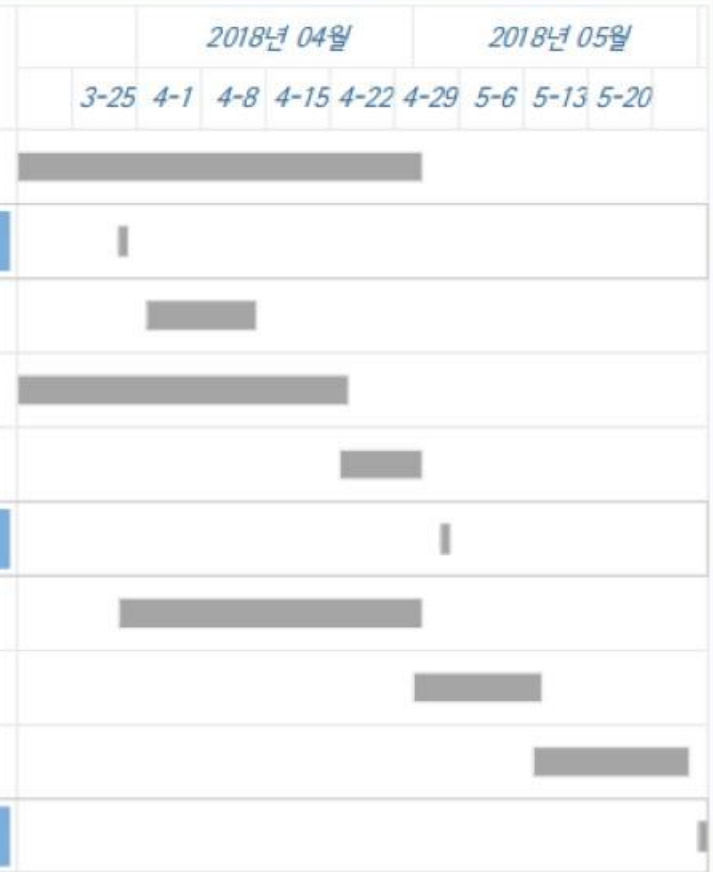
(f) Creating Bounding boxes and circles for contours



(g) Creating Bounding rotated boxes and ellipses for contours

GANTT CHART

ID	작업명	시작	완료	기간
1	Idea Generation	2018-03-19	2018-05-01	6.4w
2	1st Presentation	2018-03-30	2018-03-30	.2w
3	Motor 구동 및 이동	2018-04-02	2018-04-13	2w
4	집기 방식 제작	2018-03-19	2018-04-23	5.2w
5	1차 프로토타입 제작	2018-04-23	2018-05-01	1.4w
6	2nd Presentation	2018-05-04	2018-05-04	.2w
7	인식 및 경로 설정 알고리즘	2018-03-30	2018-05-01	4.6w
8	2차 프로토타입 제작	2018-05-01	2018-05-14	2w
9	피드백 수립 및 최종 제품 제작	2018-05-14	2018-05-30	2.6w
10	3rd Presentation	2018-06-01	2018-06-01	.2w



THANK YOU