Ball Picking System

Capstone Design I : 1st Presentation

Group 9

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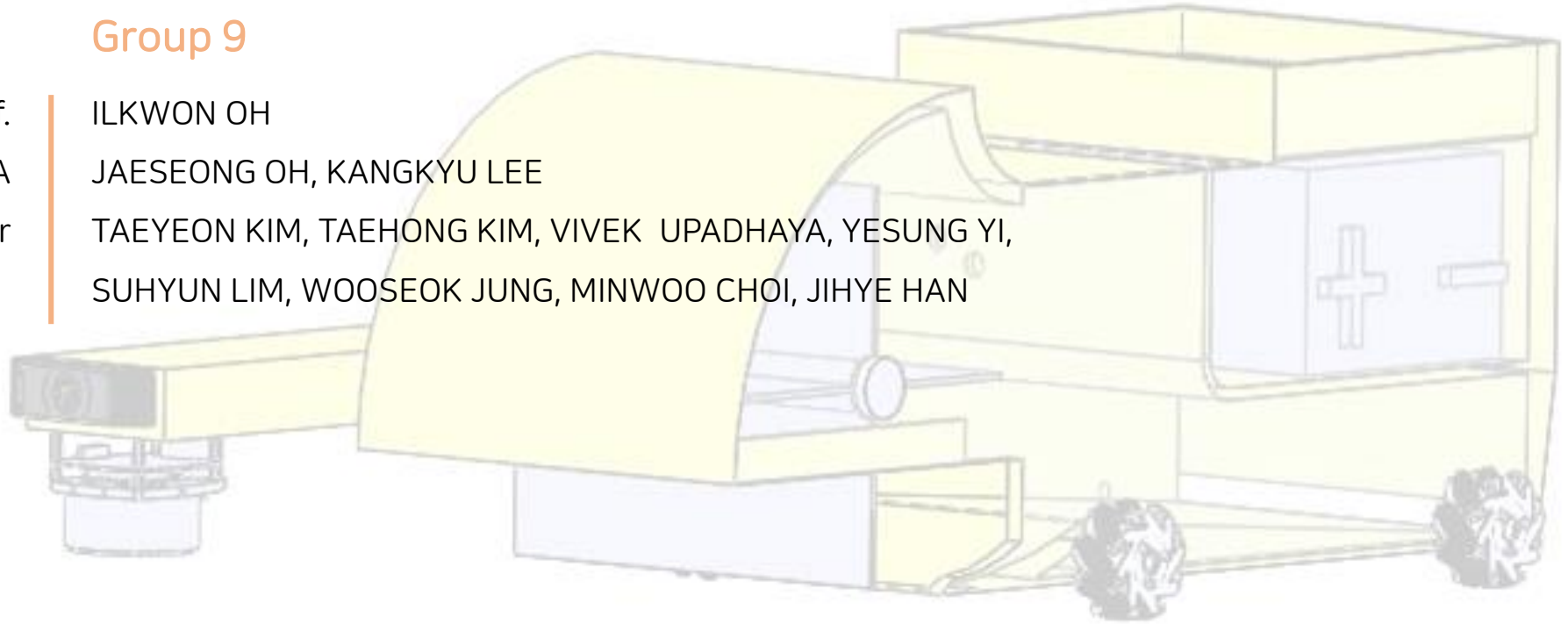

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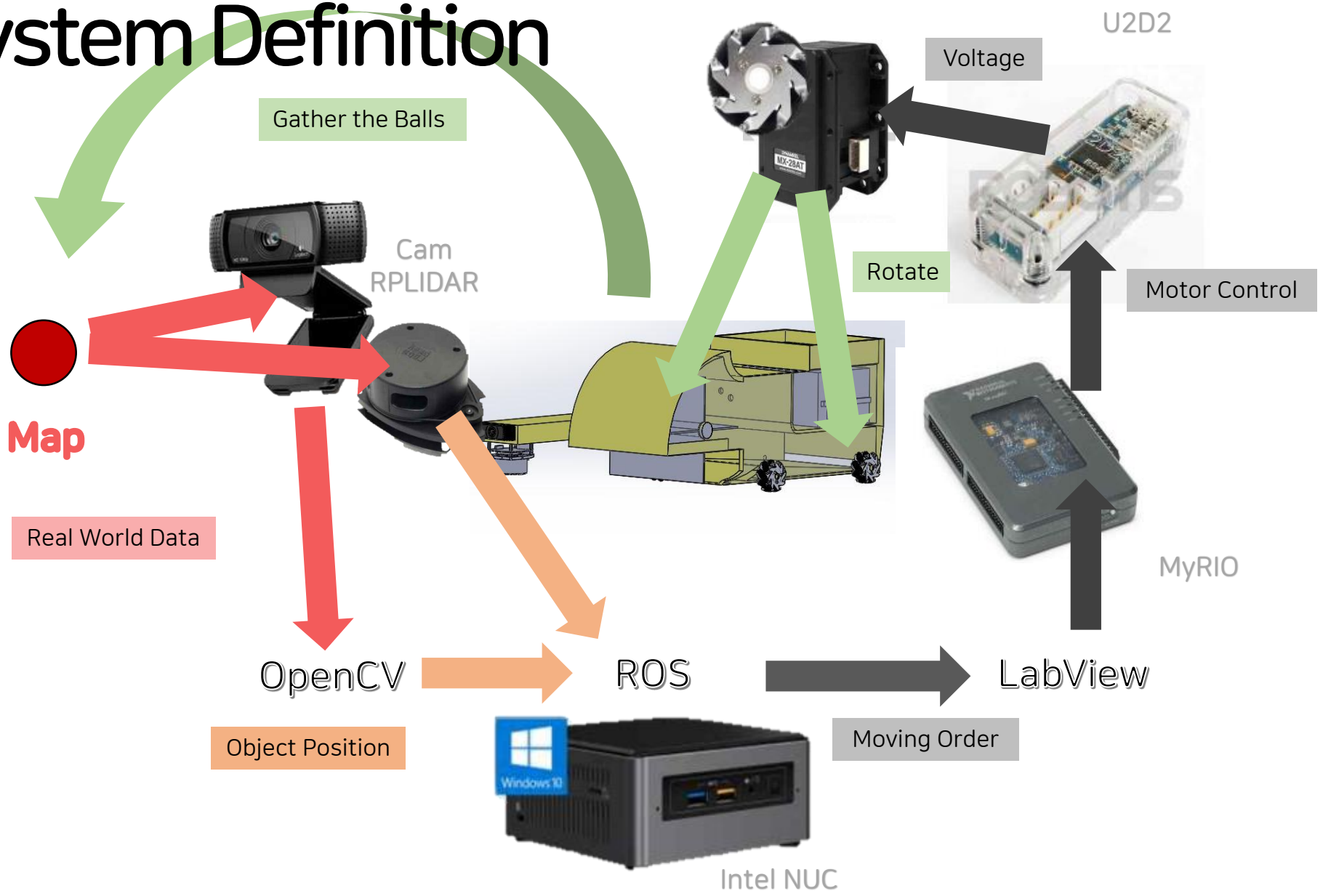
1. System Definition
2. Pick-up Design
3. Subsystem Design & Analysis
4. Progress Report
5. Conclusion & Future Plan

1. System Definition



1. System Definition
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    2-1. Design Gathering
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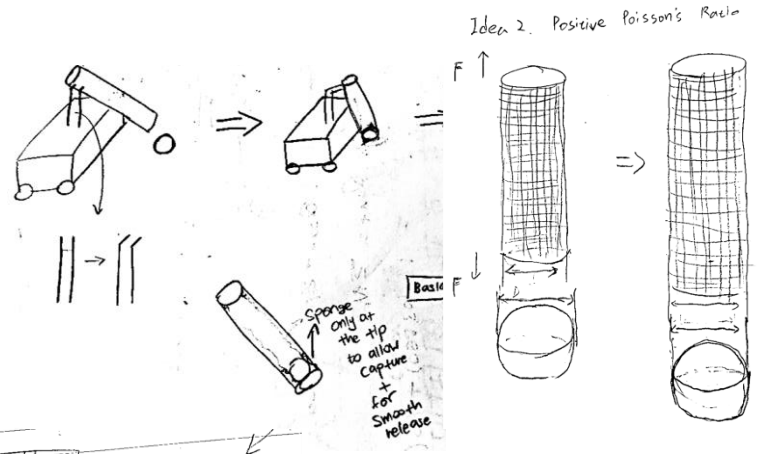
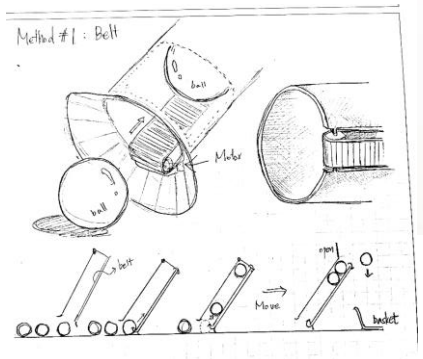
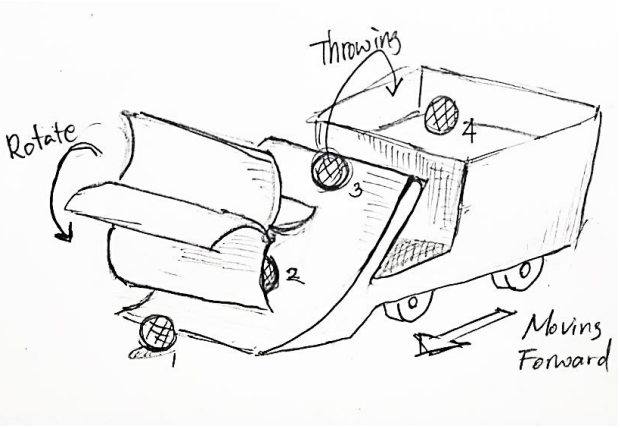
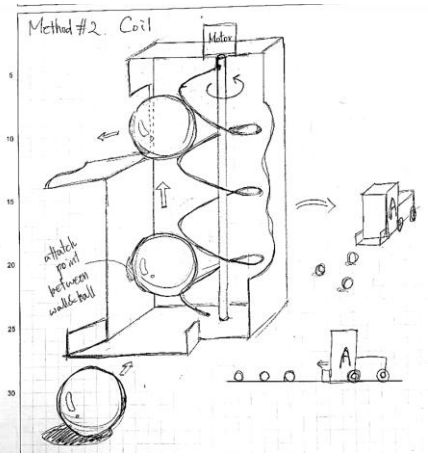
3. Subsystem Design & Analysis
4. Progress Report
5. Conclusion & Future Plan

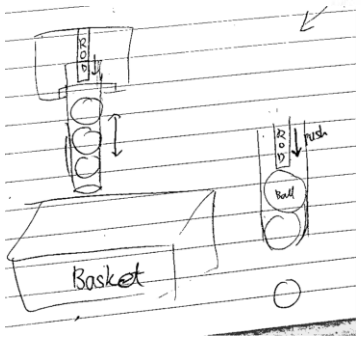
2-1. Design Gathering

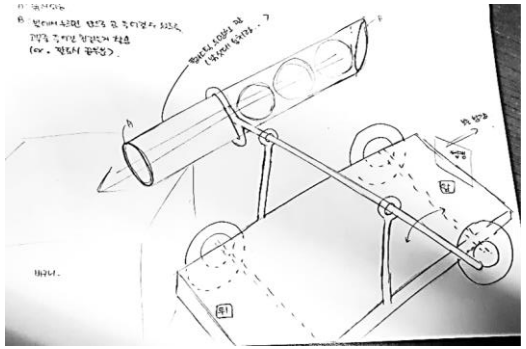


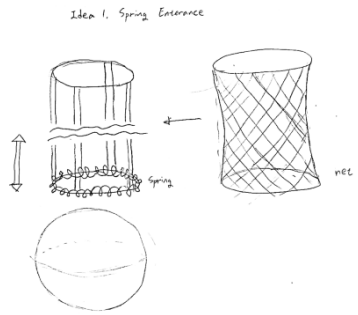


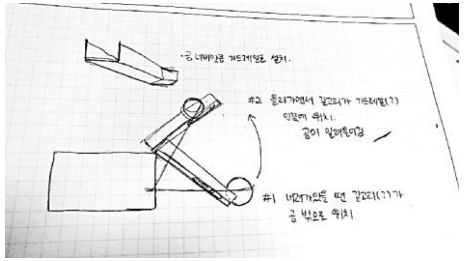


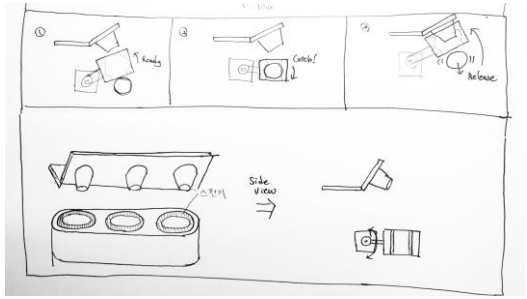


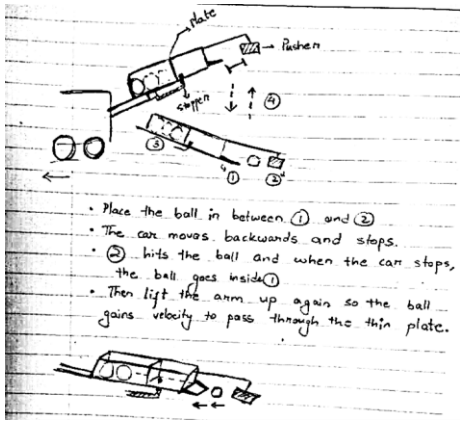




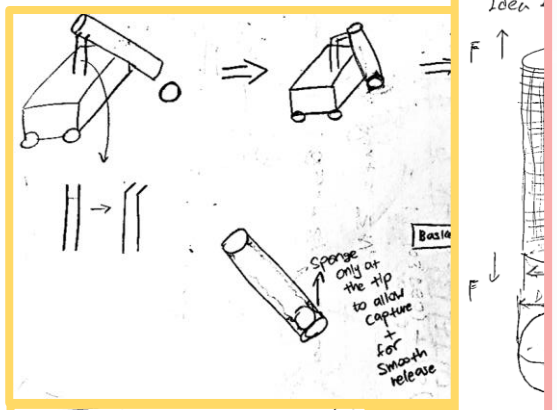


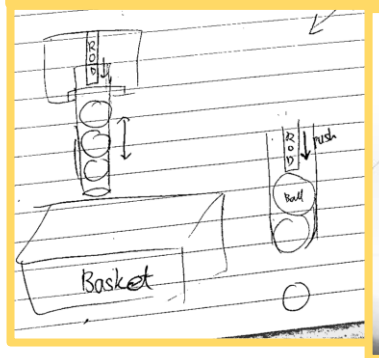




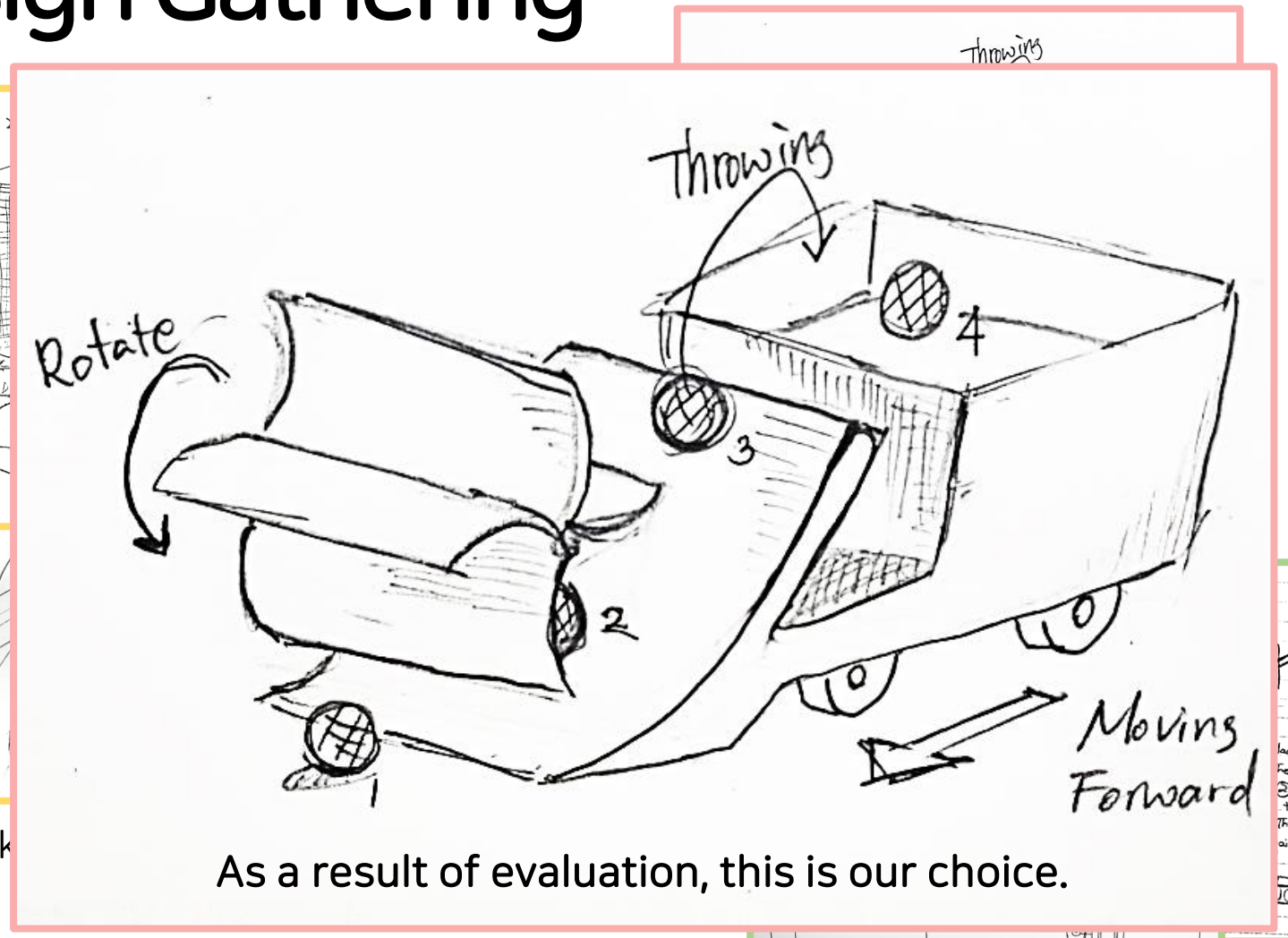


2-1. Design Gathering

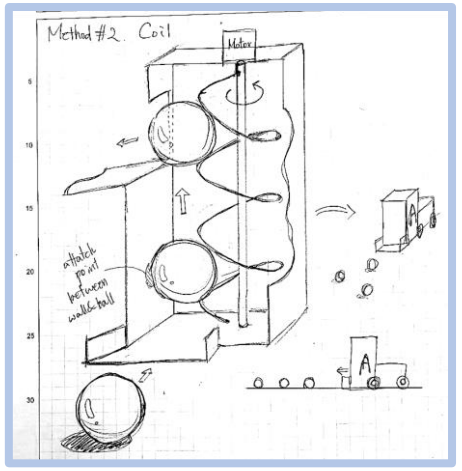




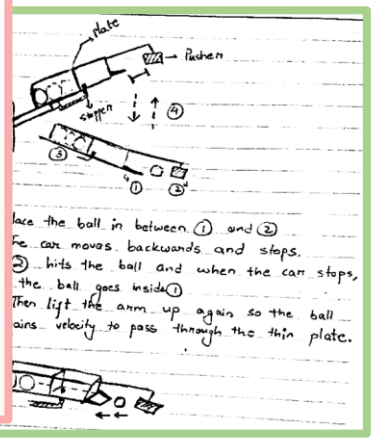
1. Pick



As a result of evaluation, this is our choice.



4. Helical Push-up



3. Pickup with other structure

2-2. Design Comparing

We needed evaluation criteria.

Overall Operation Speed

- Short the time, higher the score!
- Time taken to pick up the ball
- How many time does it stop in between pick up?

Robustness for Picking up

- Losing the ball is critical
- Consider the accuracy of picking
- Size of pick-up area

Energy Consumption

- Lower the temperature, higher the score!
- Mass & Inertia should be small
- Needs very low torque

Manufacture Cost

- Cheap material, small volume
- Simple shape for manufacturing
- Low motor specification is better

Control Difficulty

- How many actuators do we need?
- Numbers of Coordinate
- Stability for all conditions

2-2. Design Comparing

Criteria

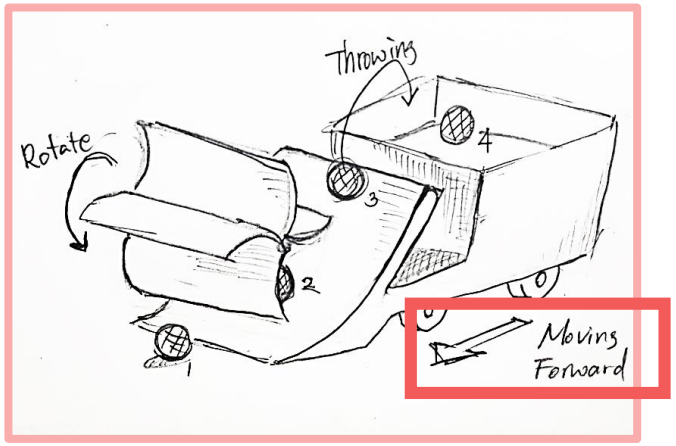
Good

Bad

<Comparing Method>

1. Draw a Criterial Line
2. Left side is Good, and right side is Bad.
3. List the methods for each criteria.

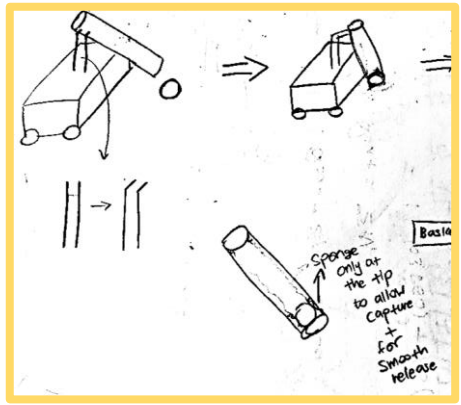
2-2. Design Comparing

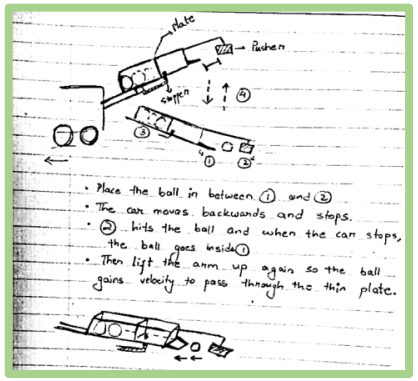


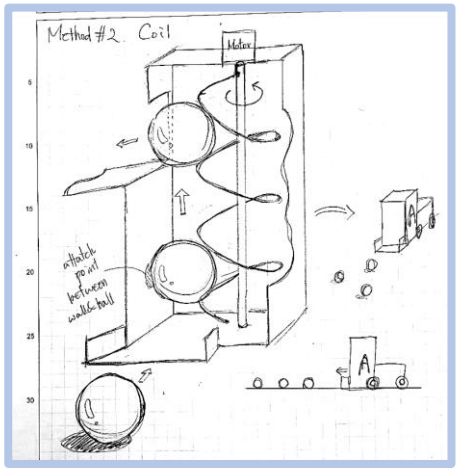
No need to stop for picking up the balls

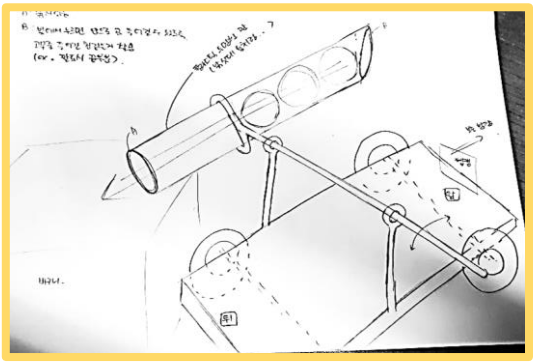
Overall Operation Speed

- Short the time, higher the score!
- Time taken to pick up the ball
- How many time does it stop in between pick up?

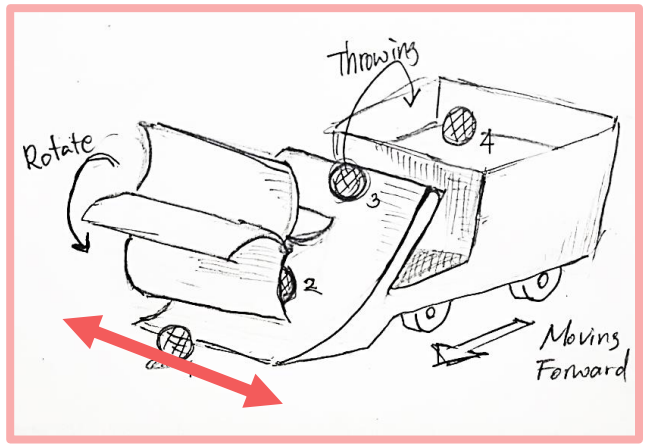


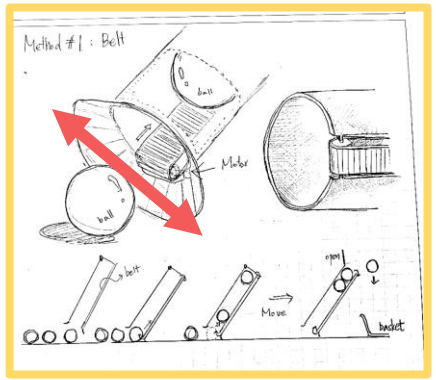


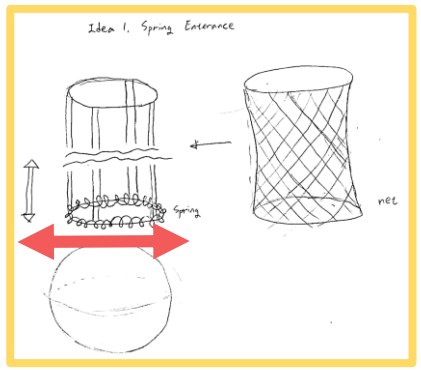




2-2. Design Comparing



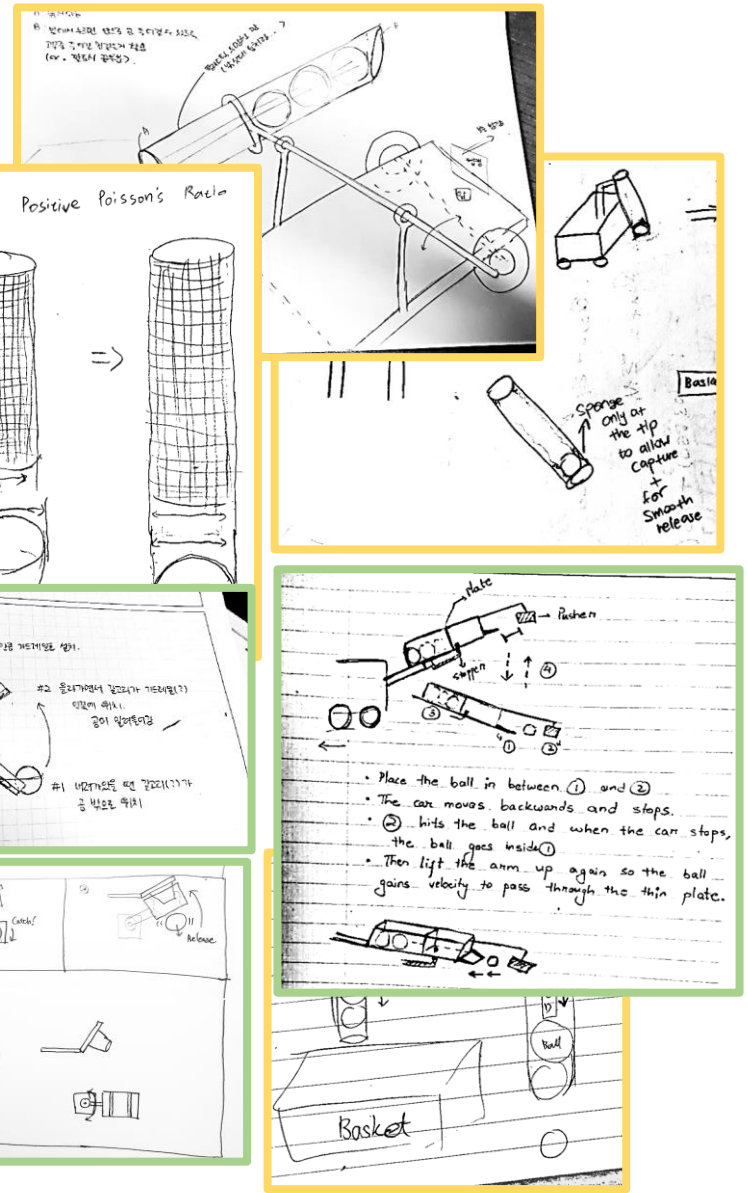




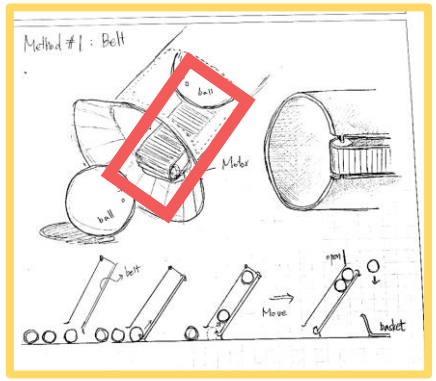
Wide entrance : Higher opportunity

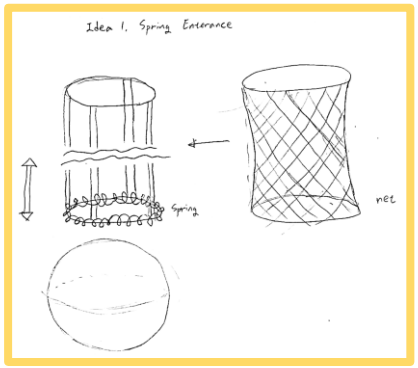
Robustness for Picking up

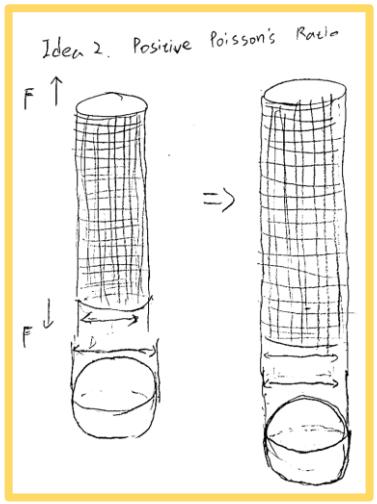
- Consider the accuracy of picking
- Losing the ball is critical
- Range of pick-up area



2-2. Design Comparing



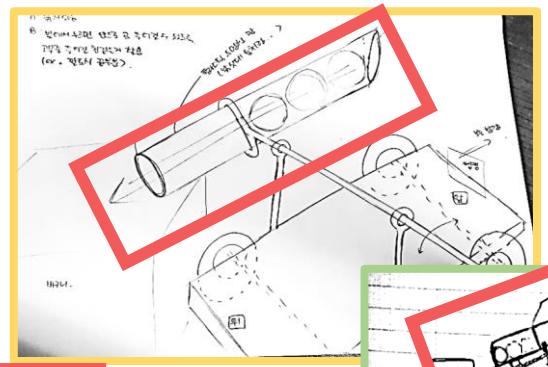


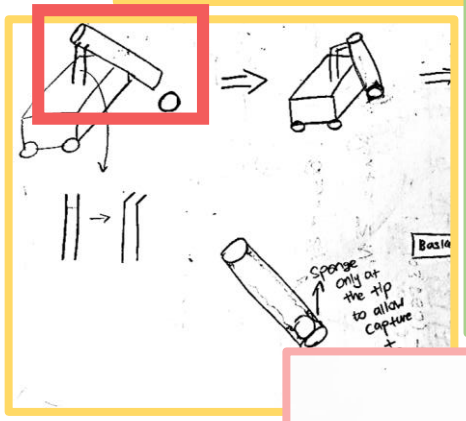


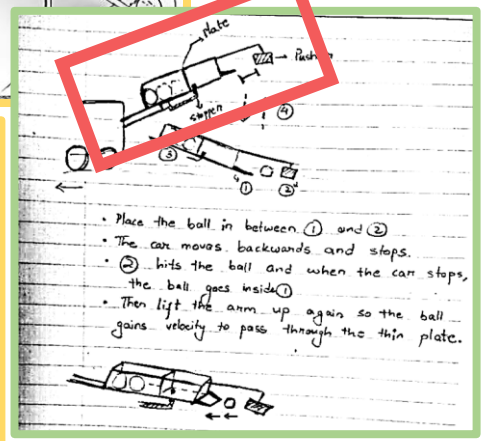
Need very small torque

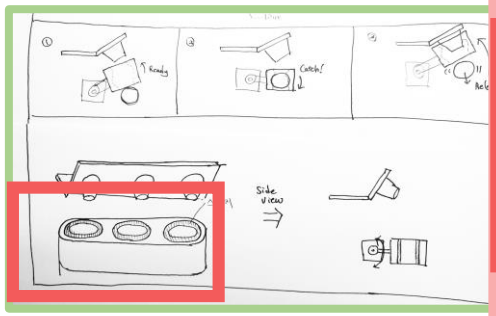
Energy Consumption

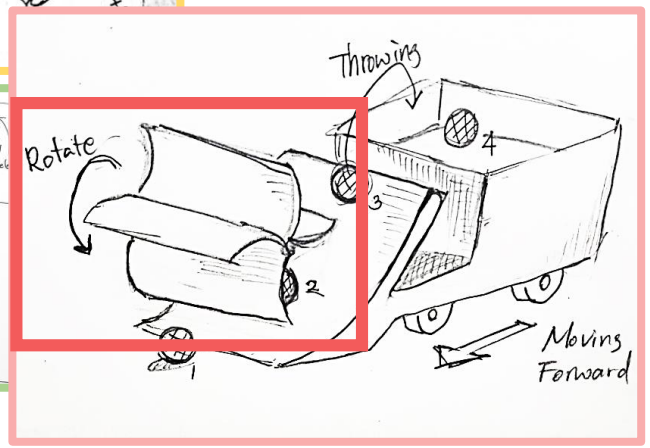
- Lower the temperature, higher the score!
- Mass & Inertia should be small
- Needs very low torque





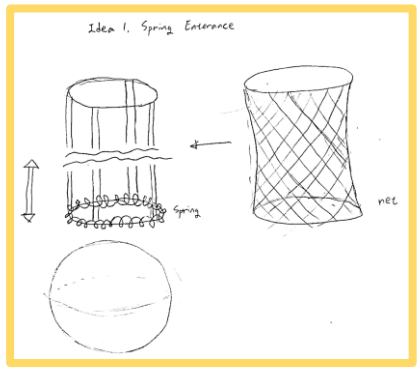


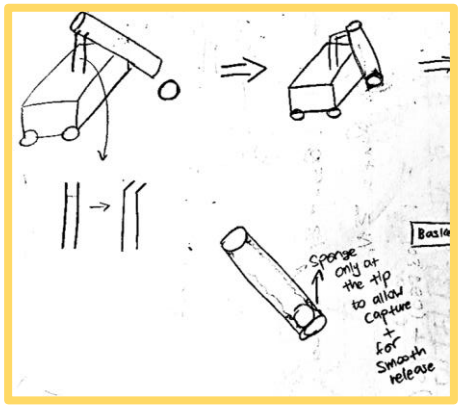


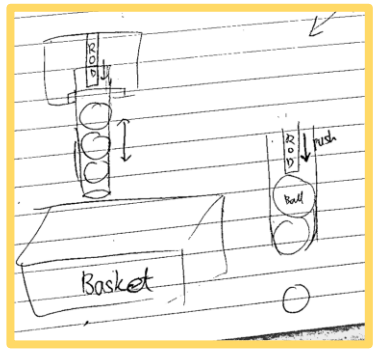


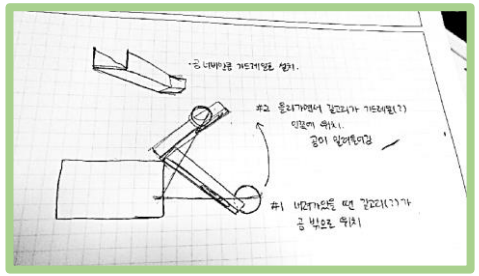
Large Inertia

2-2. Design Comparing



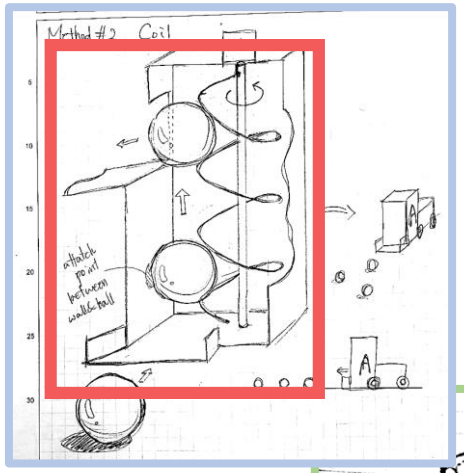


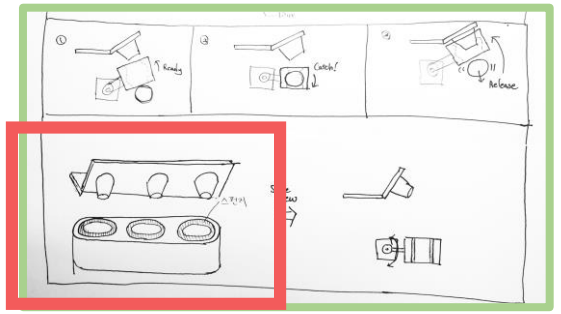


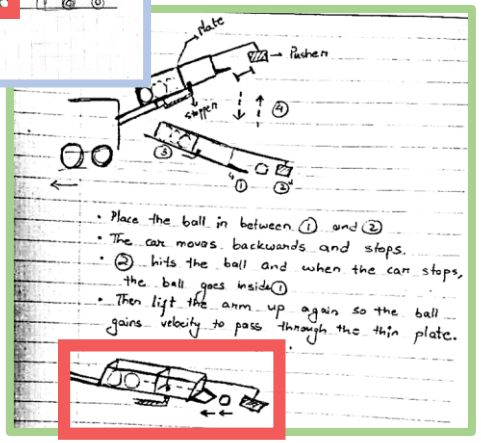


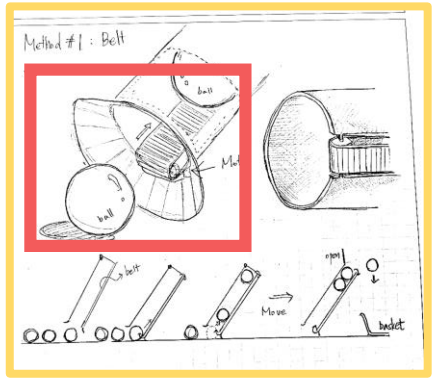
Manufacture Cost

- Cheap material, small volume
- Simple shape for manufacturing
- Low motor specification is better







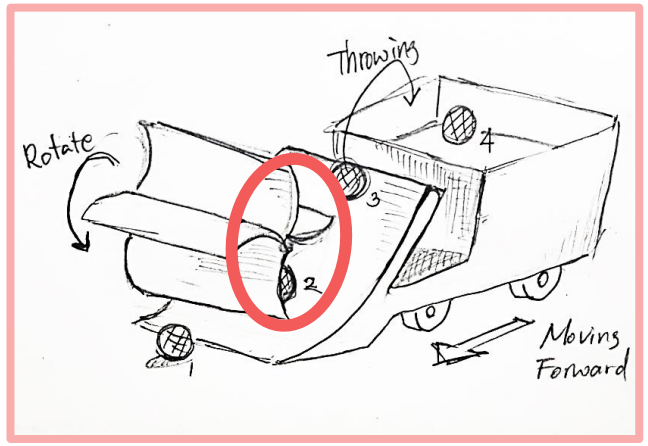


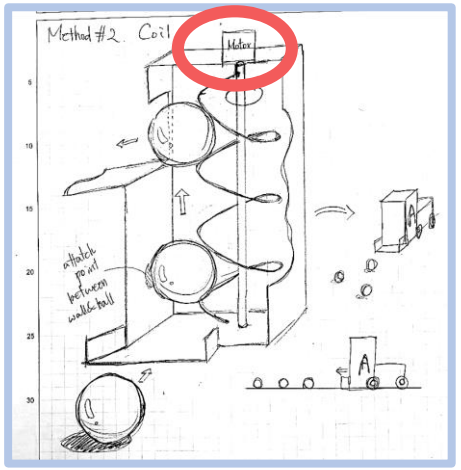
Hard to manufacture

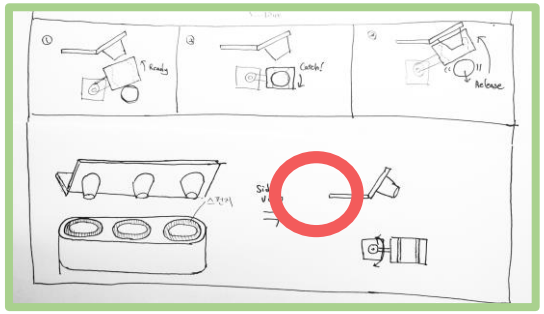
2-2. Design Comparing

Control Difficulty

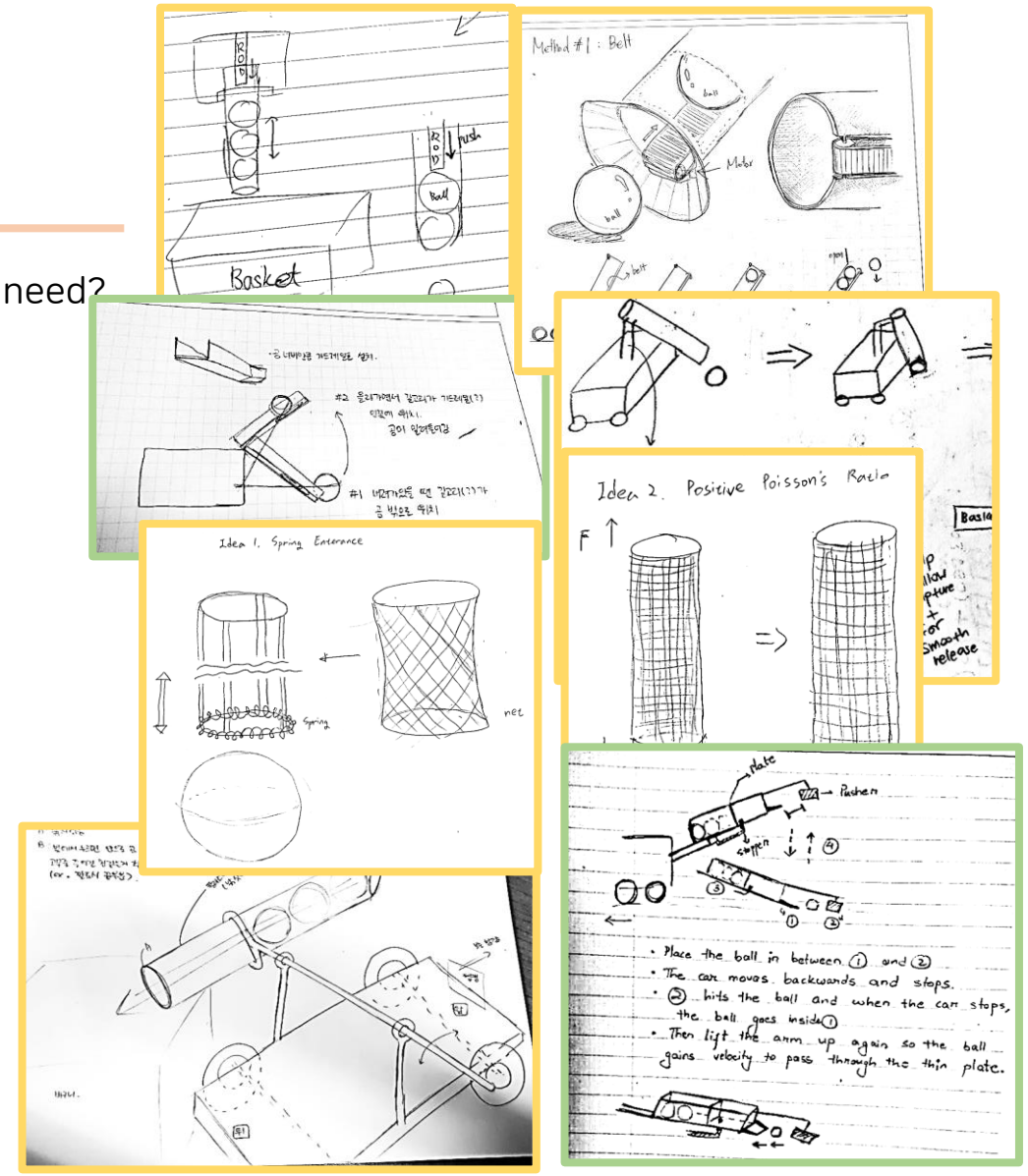
- How many actuators do we need?
- Numbers of Coordinate
- Stability for all conditions





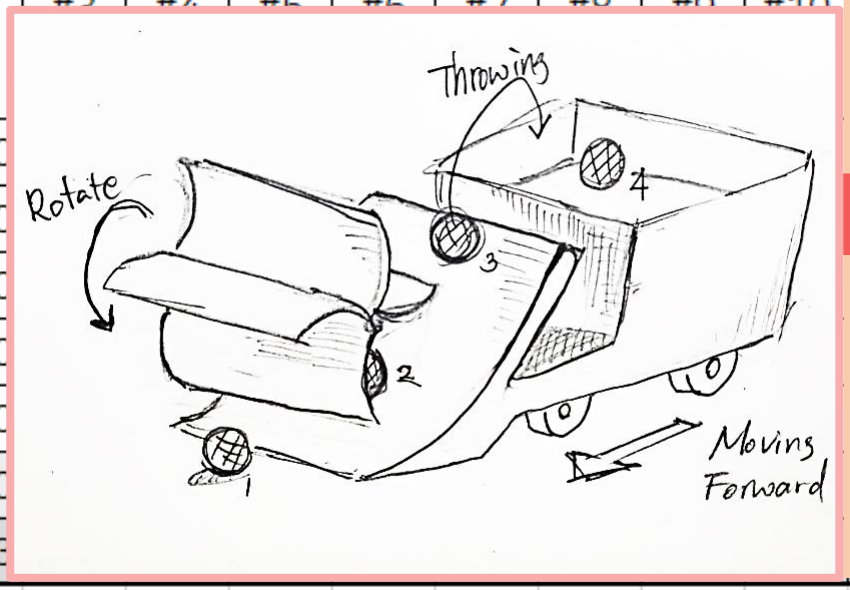


Needs only one actuator



2-2. Design Comparing

Pugh's Decision Matrix		Idea #1~11										
Issue: Choose Picking-up function & form		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Overall Operation Speed	30	70	50									90
Energy Consumption	30	60	40									40
Robustness for Picking Up	20	70	50									90
Control Difficulty	10	50	20									80
Manufacture Cost	10	60	40									60
	Total	310	200									360
	Weighted total	64	43									71



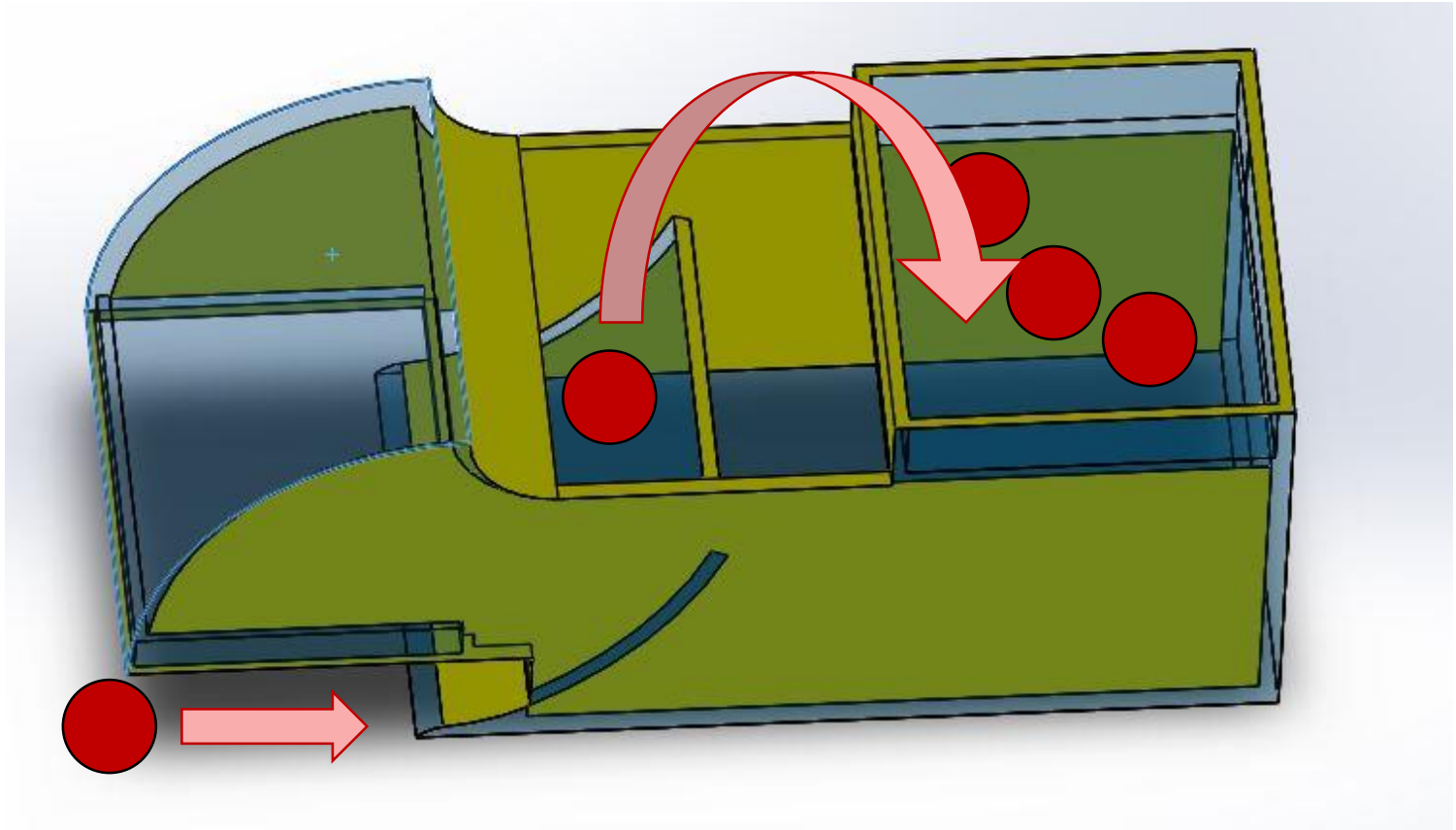
Result of Pugh's Decision Matrix

#11 is the best method for picking up the balls

There are certain strengths and weakness.

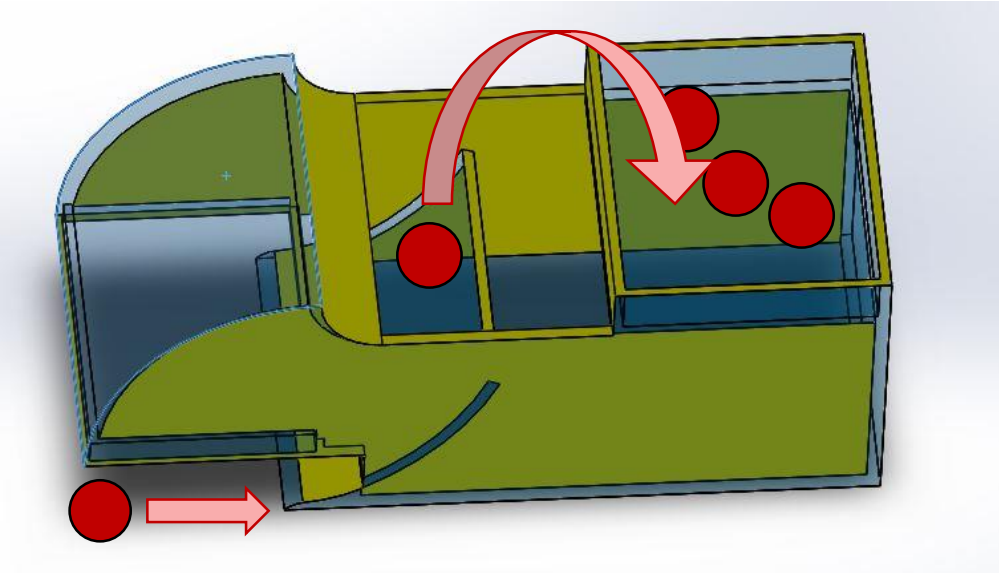
Identified a need to eliminate the weaknesses by further development

2-3. Developing our Design



Our First 3D Prototype by Solidworks

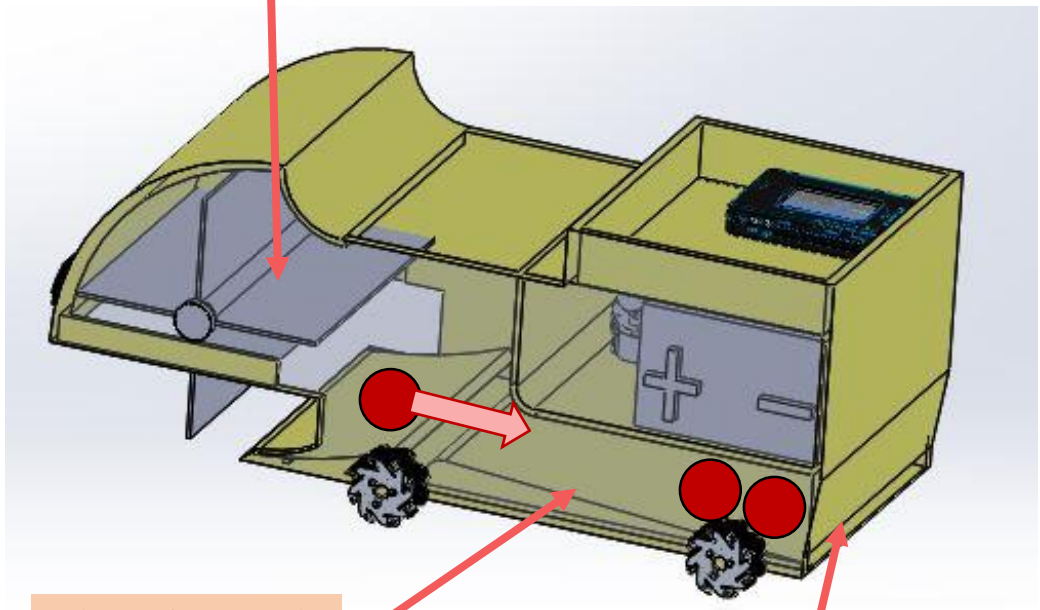
2-3. Developing our Design



Problems

1. Requires rather high speed for the ball to reach to the top basket
2. Balls could bounce, leading to capture failure
3. Difficult to release the balls to the basket (Additional actuators needed)

2-3. Developing our Design



Our Second 3D Prototype by Solidworks

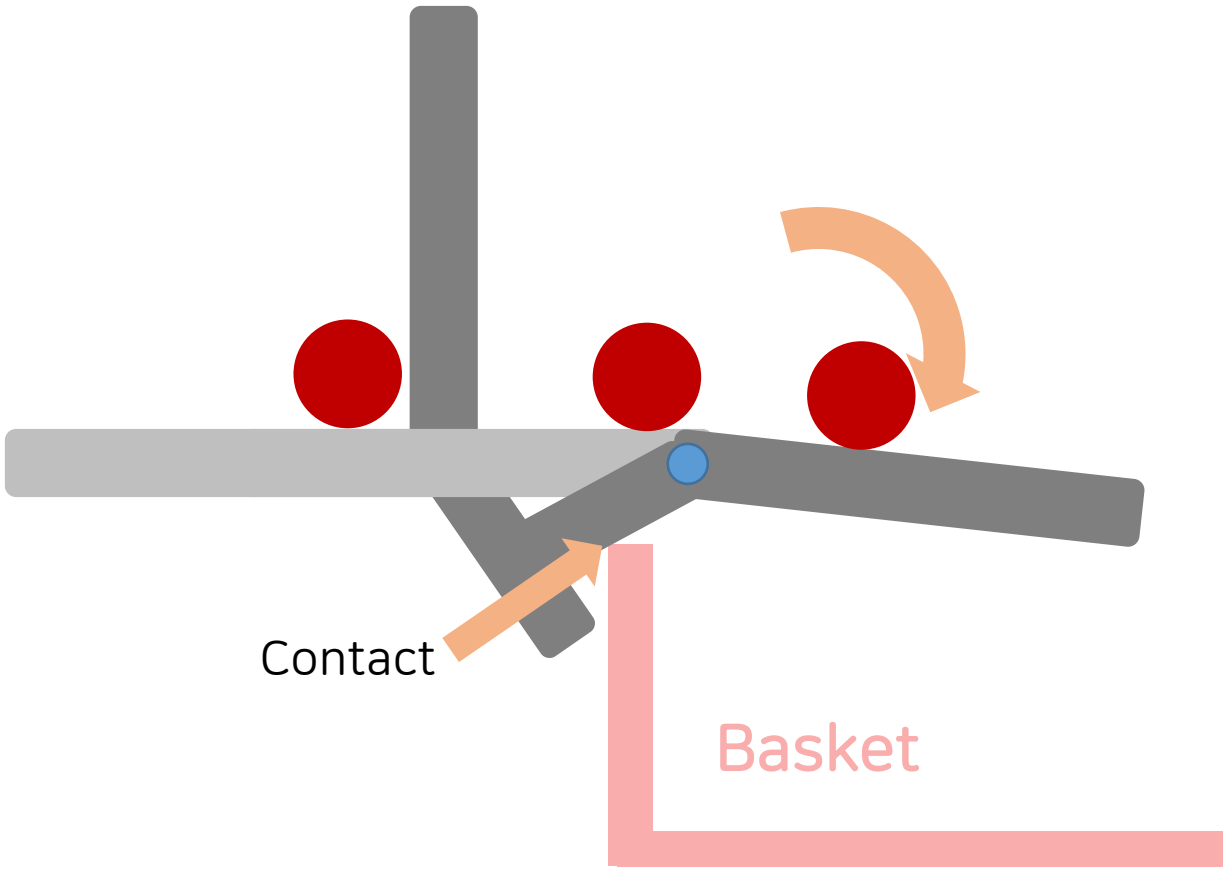
Problems

1. Requires rather high speed for the ball to reach to the top basket
2. Balls could bounce, leading to capture failure
3. Difficult to release the balls to the basket (Additional actuators needed)

Solutions

1. No need to "throw" the balls upwards. Just "push" the balls behind when they enter the fan
2. Then, the balls just roll down along the slope
3. Non-actuator mechanism for ball release

2-3. Developing our Design

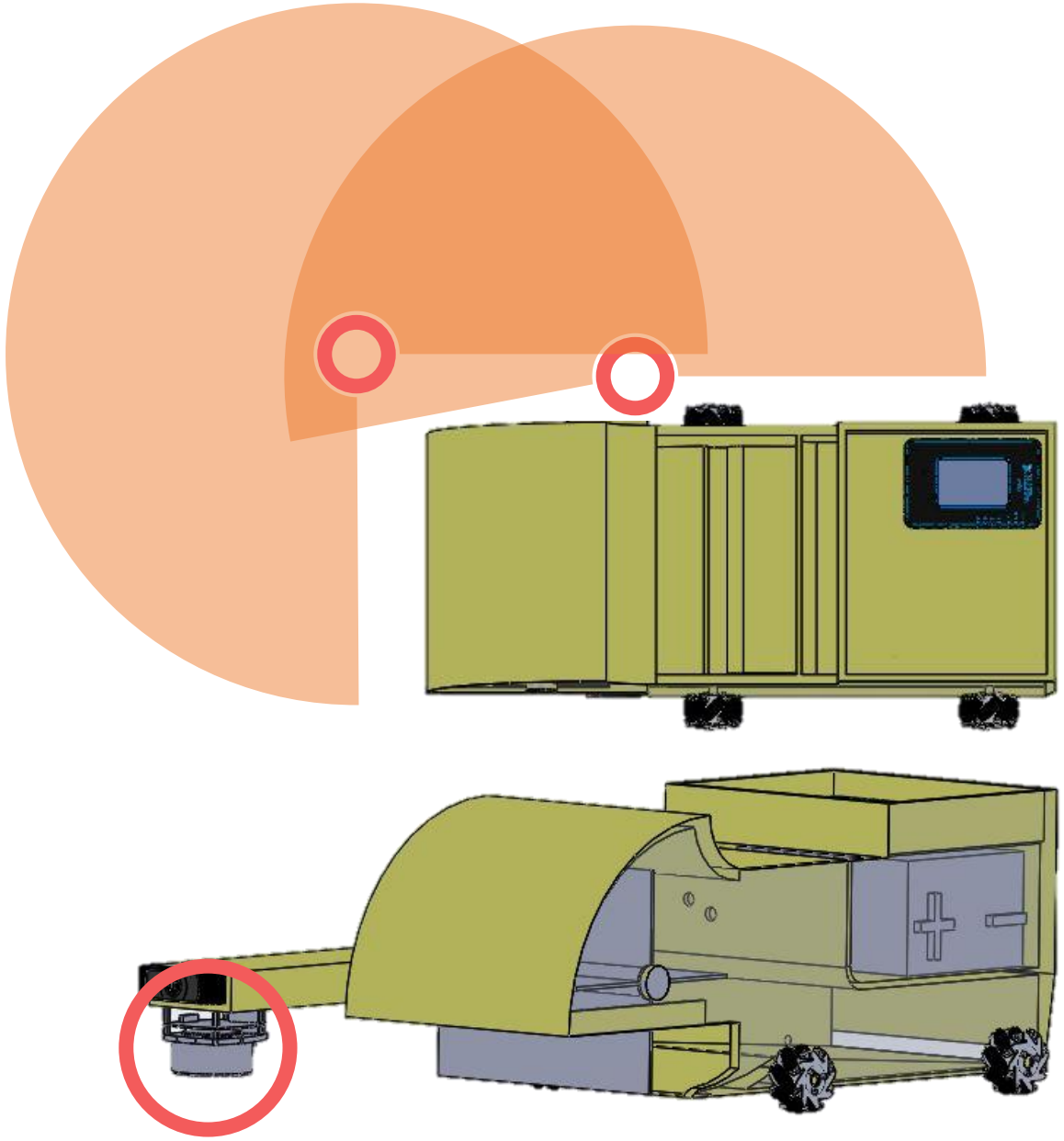


Non-actuator mechanism

< Opening Non-actuator stopper sequence>

1. As the car moves backwards, the stopper contacts with the basket.
2. The stopper is opened and the slope is formed towards the basket.
3. The balls roll down the slope.

2-3. Developing our Design



Our Third 3D Prototype by Solidworks

<RPLIDAR location : L frame>

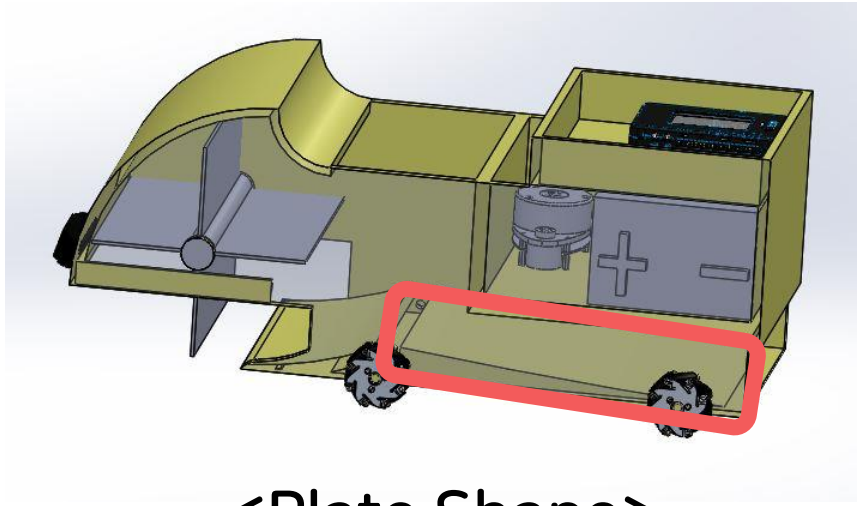
- Single height detection system
- The body can obscure the field of view.
- For wide angle detection

<Webcam Location : Same with RPLIDAR >

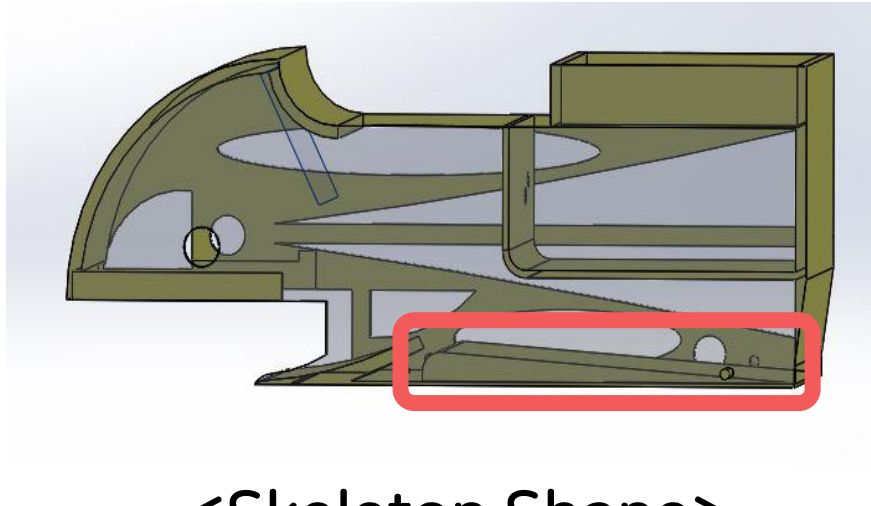
- By making the positions of Webcam, and RPLIDAR same, it is not necessary to perform additional calculation on position correction.

1. System Definition
2. Pick-up Design
3. Subsystem Design & Analysis
   - Body part
   - Heat Transfer
   - Vibration Reduction
   - ROS Integration
4. Progress Report
5. Conclusion & Future Plan

3-1. Body part



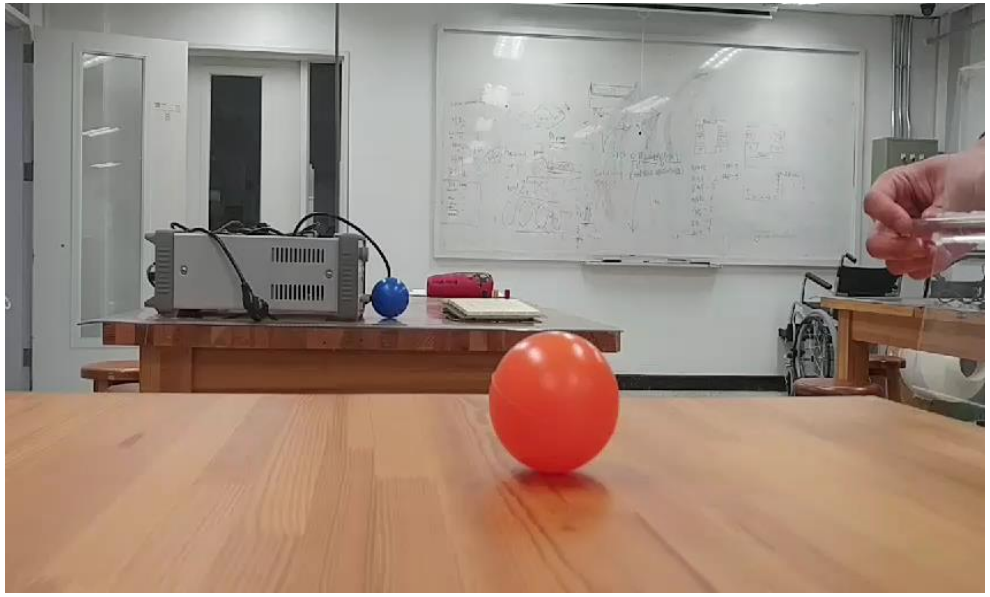
<Plate Shape>



<Skeleton Shape>

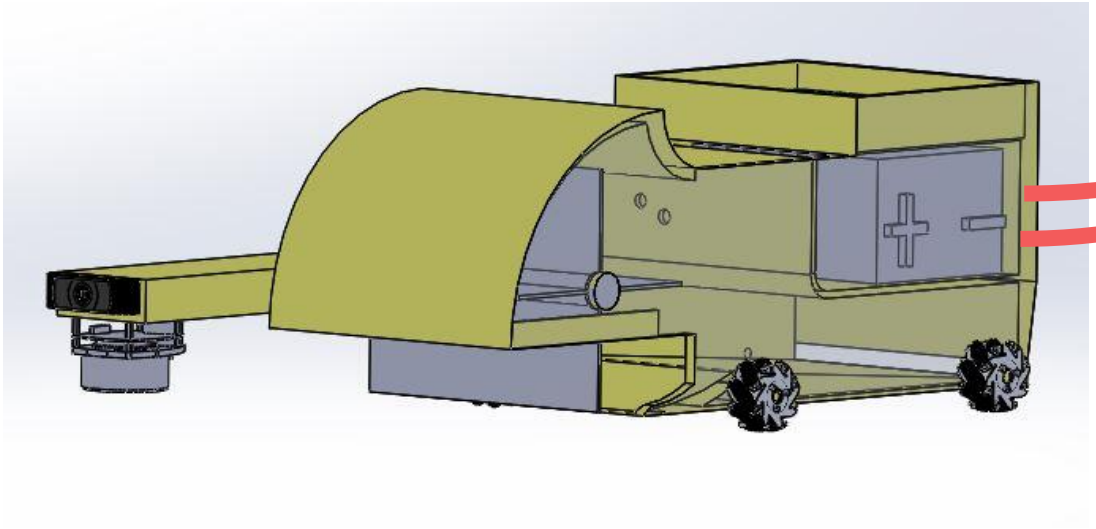
- To prevent body from being heavier → Reducing load for motor control
- Calculate slope which balls can't escape when mobile system brakes abruptly

3-1. Body part



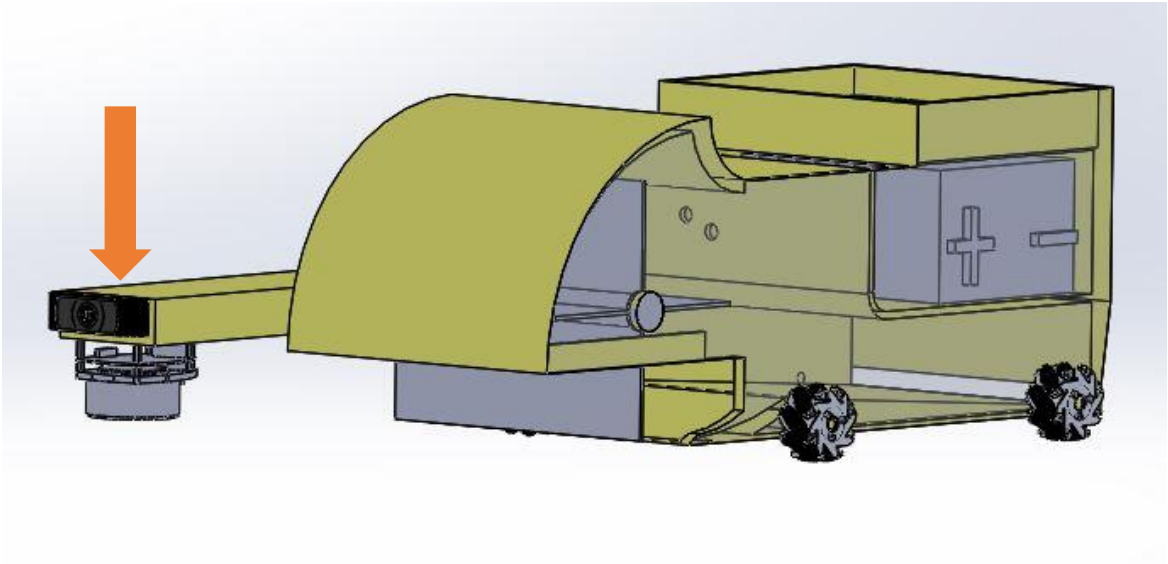
- Experimented picking balls with physical prototype of the fan
- Need to experiment more accurately by motor

3-2. Heat Transfer

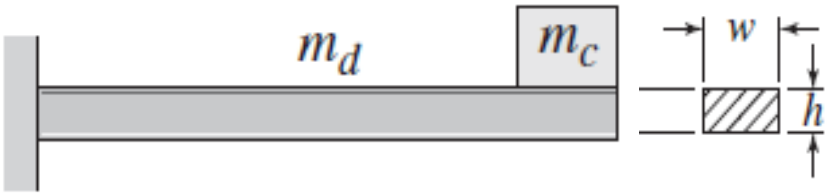


- **Minimizing battery load**
  - Using less motors
  - Making body much lighter by skeleton shape
- **Maximizing ventilation**
  - Allowing air flow by skeleton shape
- **Various methods to minimize heat**
  - Fin fan cooler, heat exchanger etc

3-3. Vibration Reduction



Cantilever beam



$$m_e = m_c + 0.23m_d$$

$$w_n = \sqrt{\frac{Ewh^3}{4(m_c + m_d)}}$$

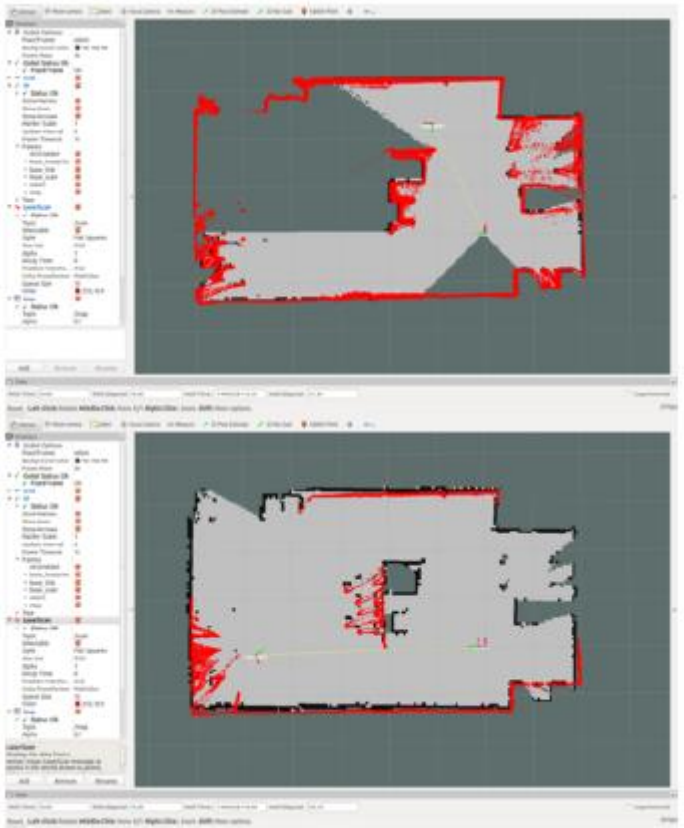
$$k = \frac{Ewh^3}{4L^3}$$

w = beam width
h = beam thickness
L = length of beam

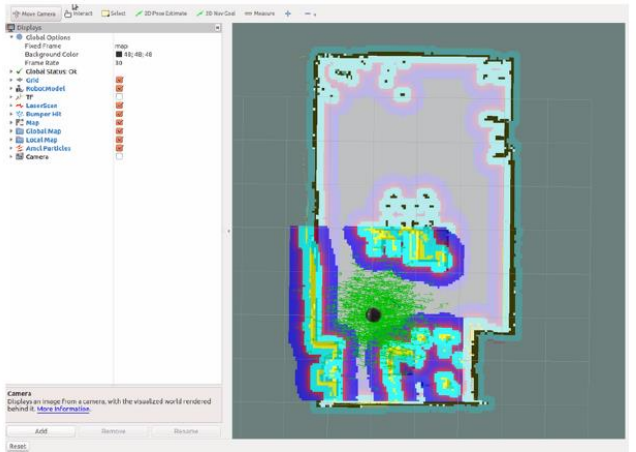
- Accelerate or brake abruptly
- Resonance between rotating wheels and RPLIDAR, webcam structure

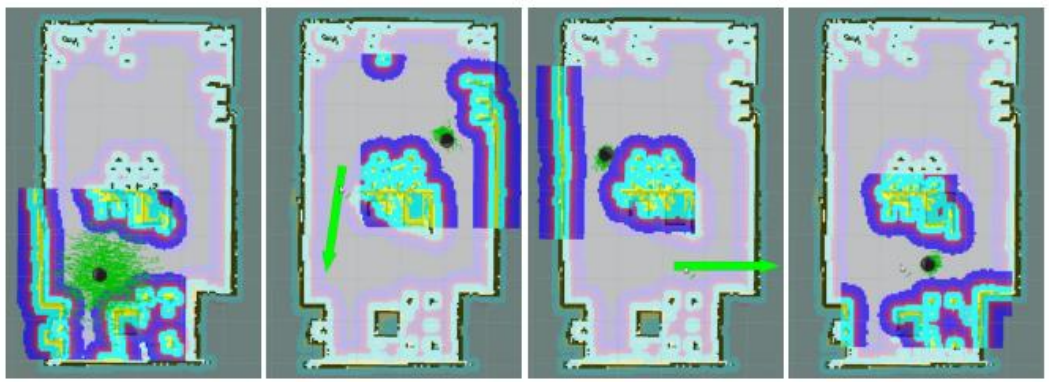
- Design the structure avoiding resonance by changing natural frequency
- Tuned mass damper

3-4. ROS Integration



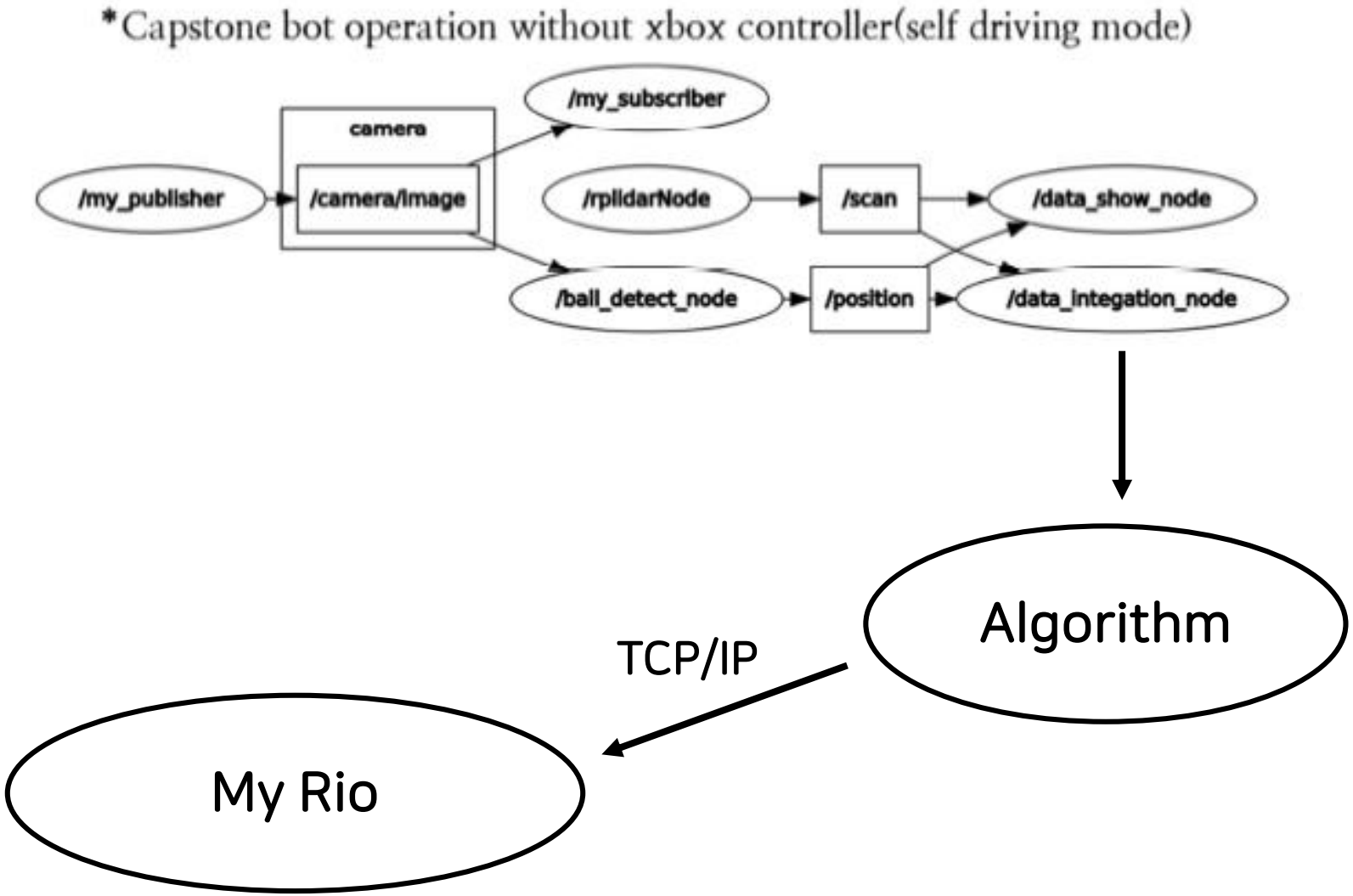
<SLAM>





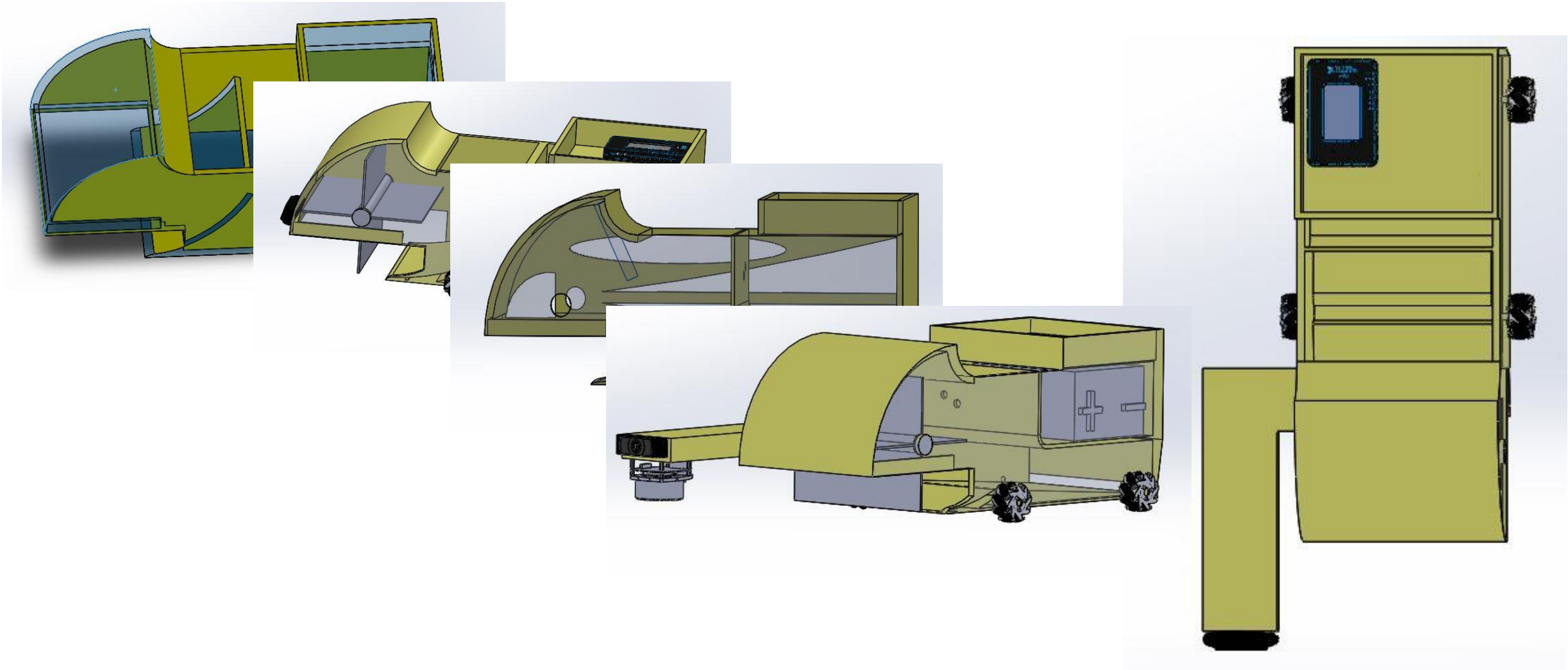
<Navigation>

3-4. ROS Integration

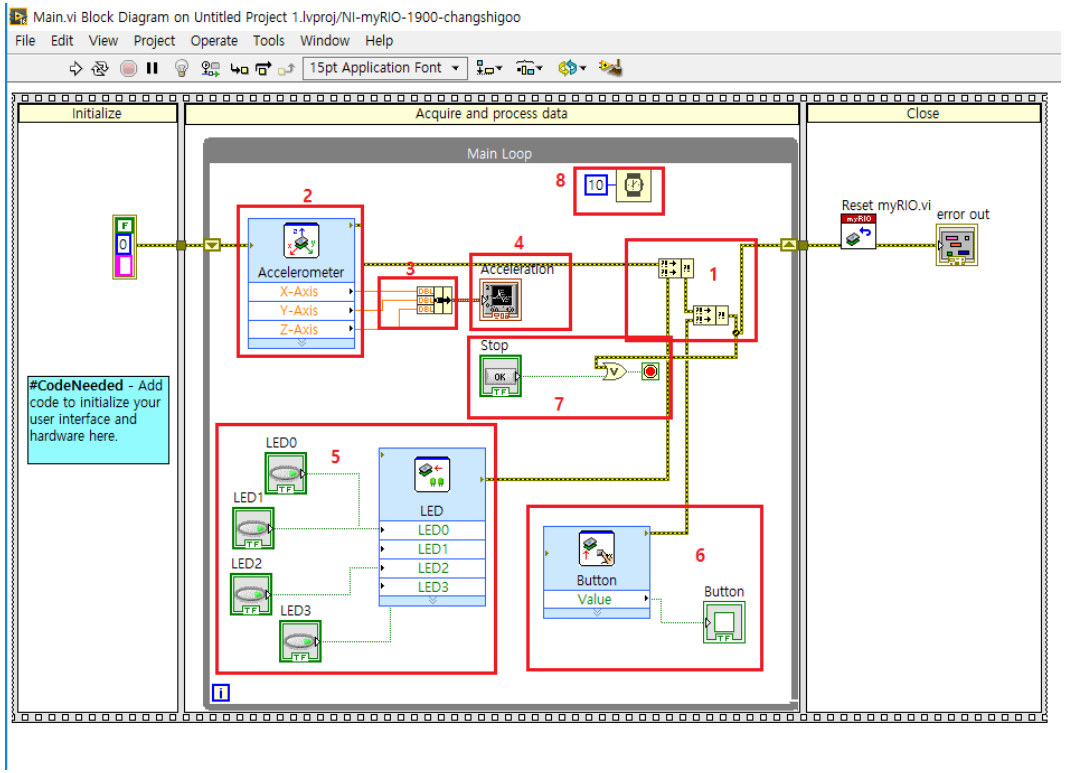


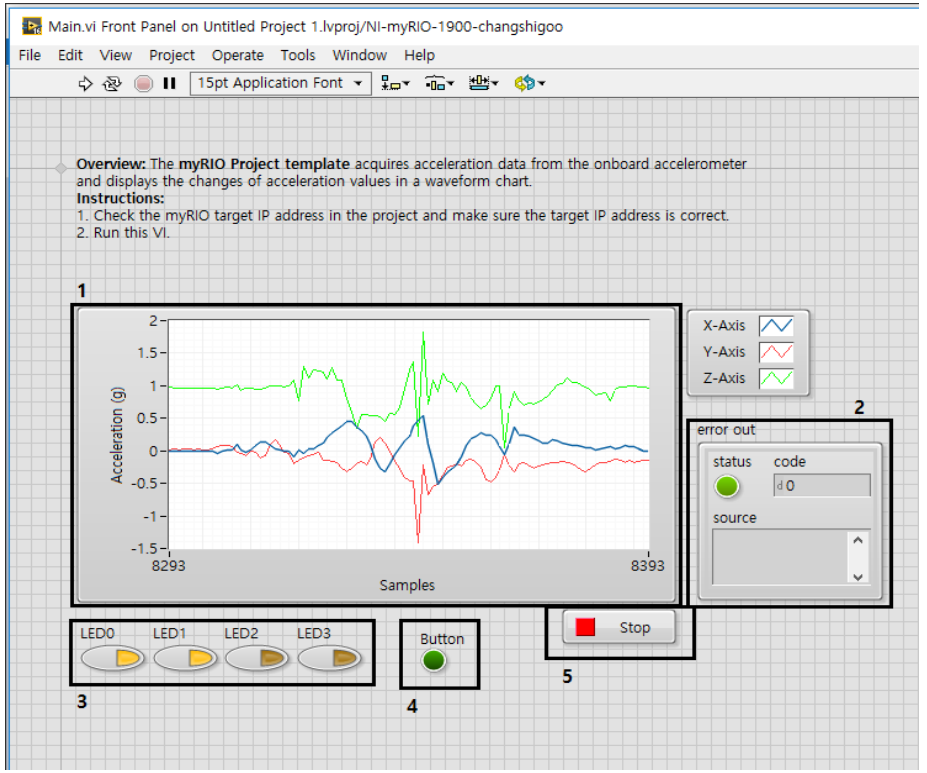
1. System Definition
2. Pick-up Design
3. Subsystem Design & Analysis
4. Progress Report
5. Conclusion & Future Plan

4. Progress Report(Solidworks)



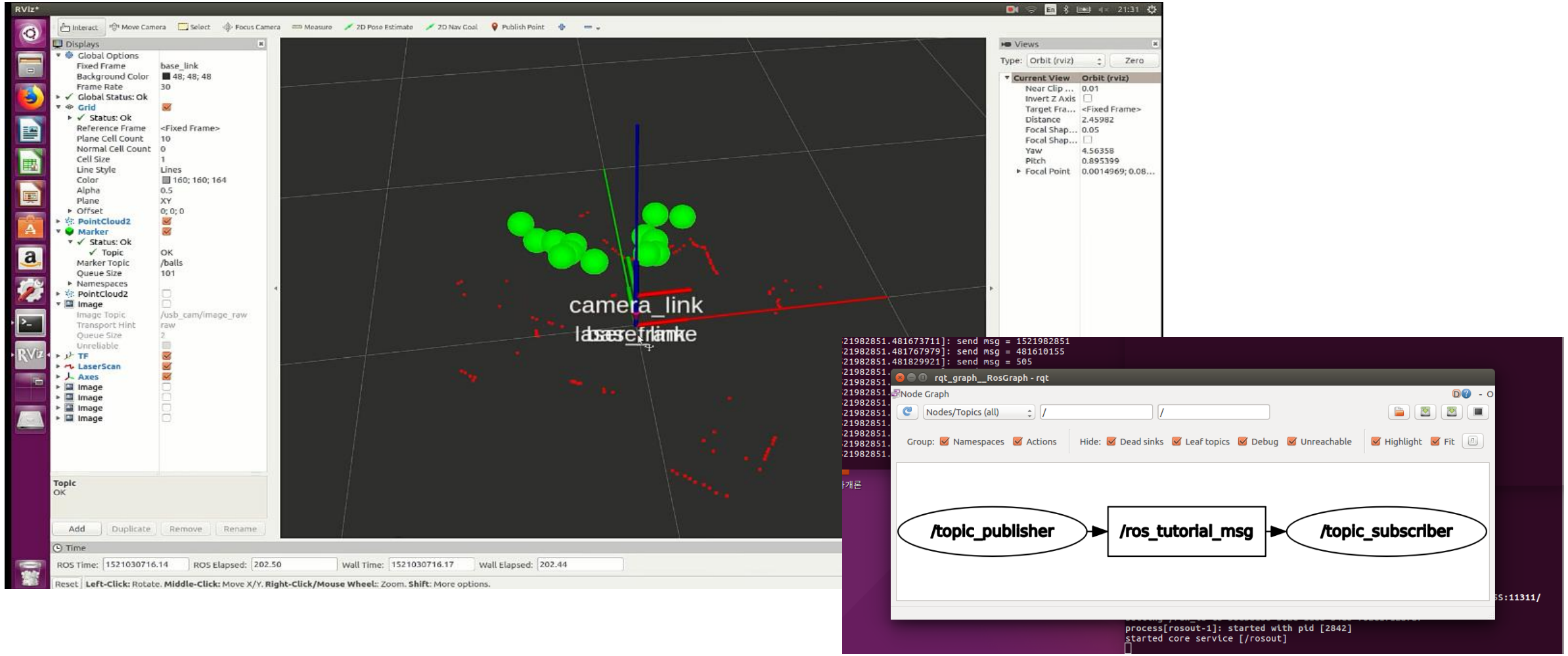
4. Progress Report(LABVIEW)



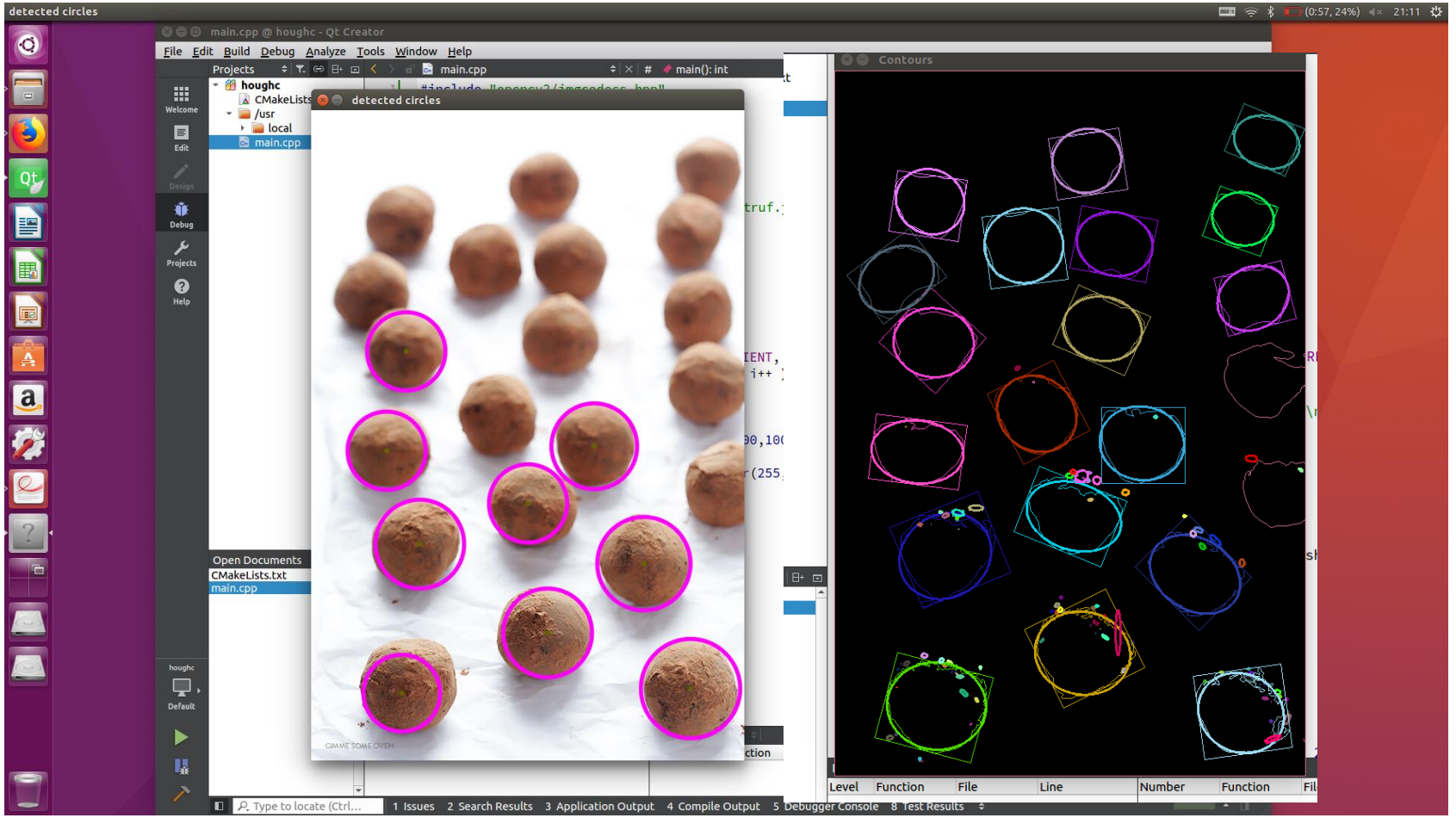


- Connect My Rio and LABVIEW
- Code using acceleration sensor, LED and button
- Control dynamixel motor with mechanum wheel

4. Progress Report(ROS)



4. Progress Report(Open CV)



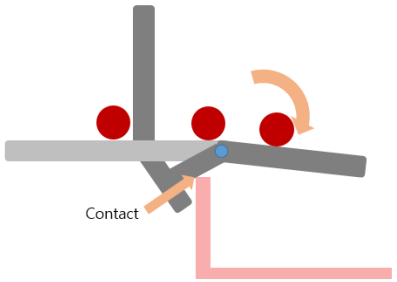
- Find parameter values by calibration

1. System Definition
2. Pick-up Design
3. Subsystem Design & Analysis
4. Progress Report
5. Conclusion & Future Plan

5. Conclusion & Future plan

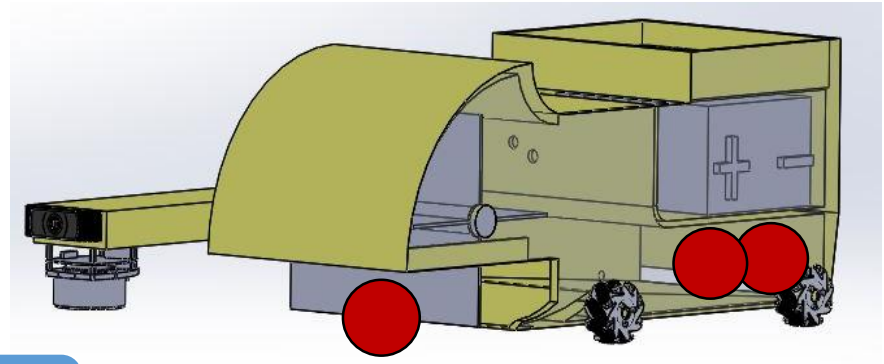
Easy to pick and move balls quickly

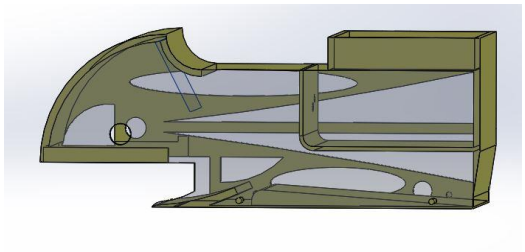
- Able to pick up balls as it moves
- Non-actuator mechanism for releasing balls



Minimize battery load

- Using less motors
- Skeleton body for light weight





Easy to manufacture

- Simple structure

Maximize ventilation

- Allowing air flow by skeleton body

5. Conclusion & Future plan

- Solid Works : Complete dividing the whole design into sub parts
- LABVIEW : Calculate motor input to move mobile system
- ROS : Integrate data from RPLIDAR and webcam or XBOX
- Open CV : Detect the balls and distinguish their color
- Heat Transfer & Vibration Reduction : Begin after a prototype is tested