Hybrid System

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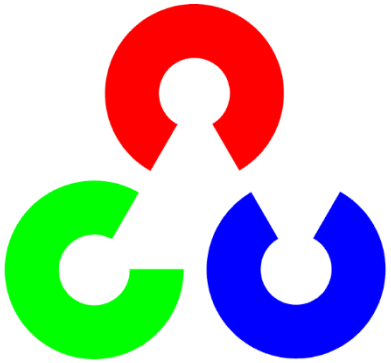
Why Hybrid?

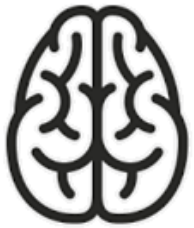


Mechanincal Engineering

Contents

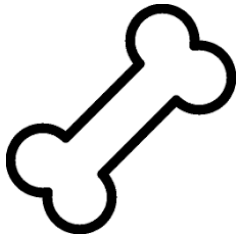
System Definition

Pick up a certain ball
And
Drop it at a certain place



ROS : Integrating all the systems and Transfer signals from one subsystem to another

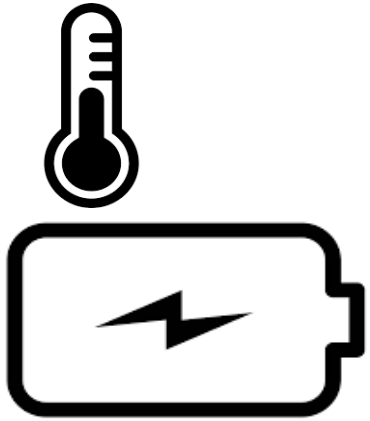
Open CV : Detect the ball's location and Make precise signal



Solidworks : Precisely and Cost-effectively design the system

Labview : Elaborately control the system

Problems

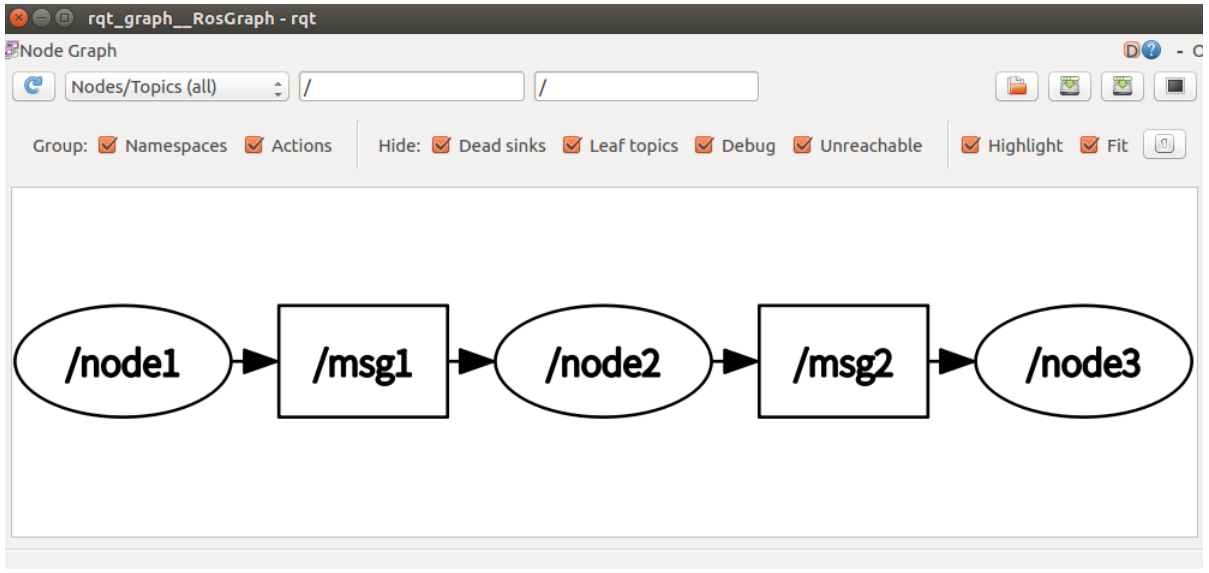


Should do the task
Energy Efficiently

All task should be done
In 5 minutes

Work should be done
Precisely

ROS



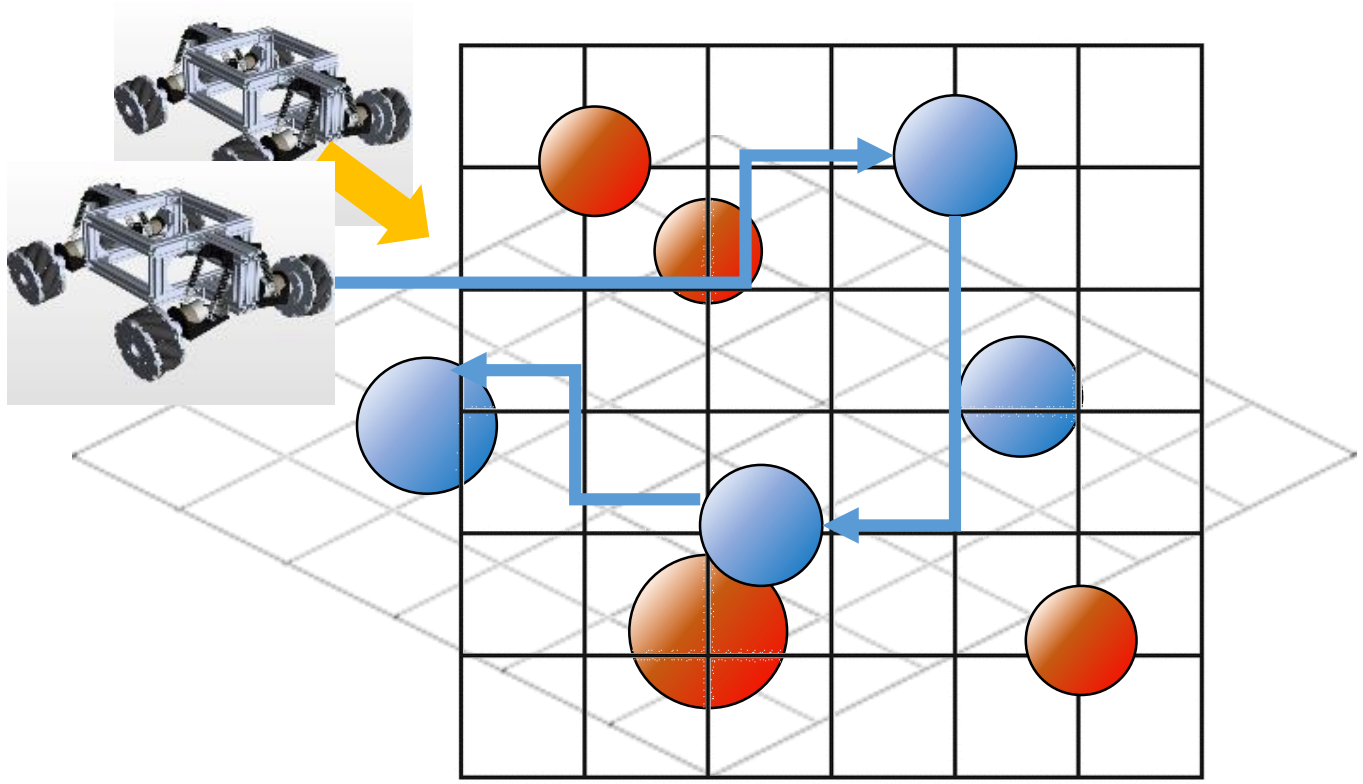

```
//Get Ball Process//

Car move to closest ball (keep certain distance from the ball)
Lidar on

If ( correct coordinate ) {
        Lidar off
}
Else {
        repeat “mapping process”
}
camera on
        run “Pick up”
```

Vision

Detect Balls

Draw Map

Calculate Path

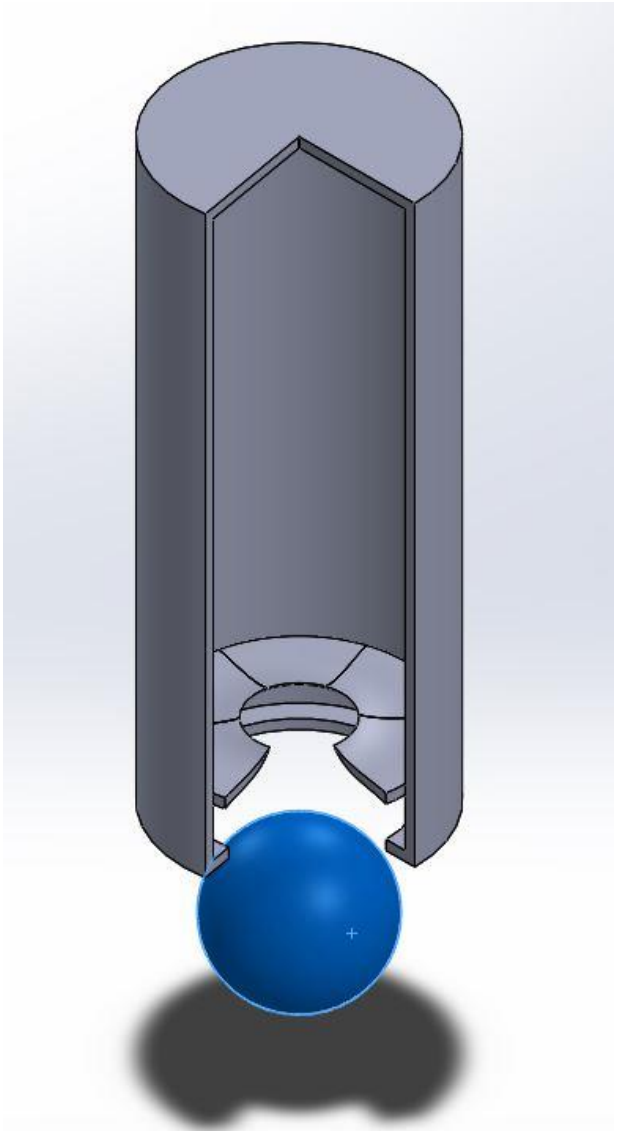


Reduce Error by Periodically Re-calculating Path

Pick-Up

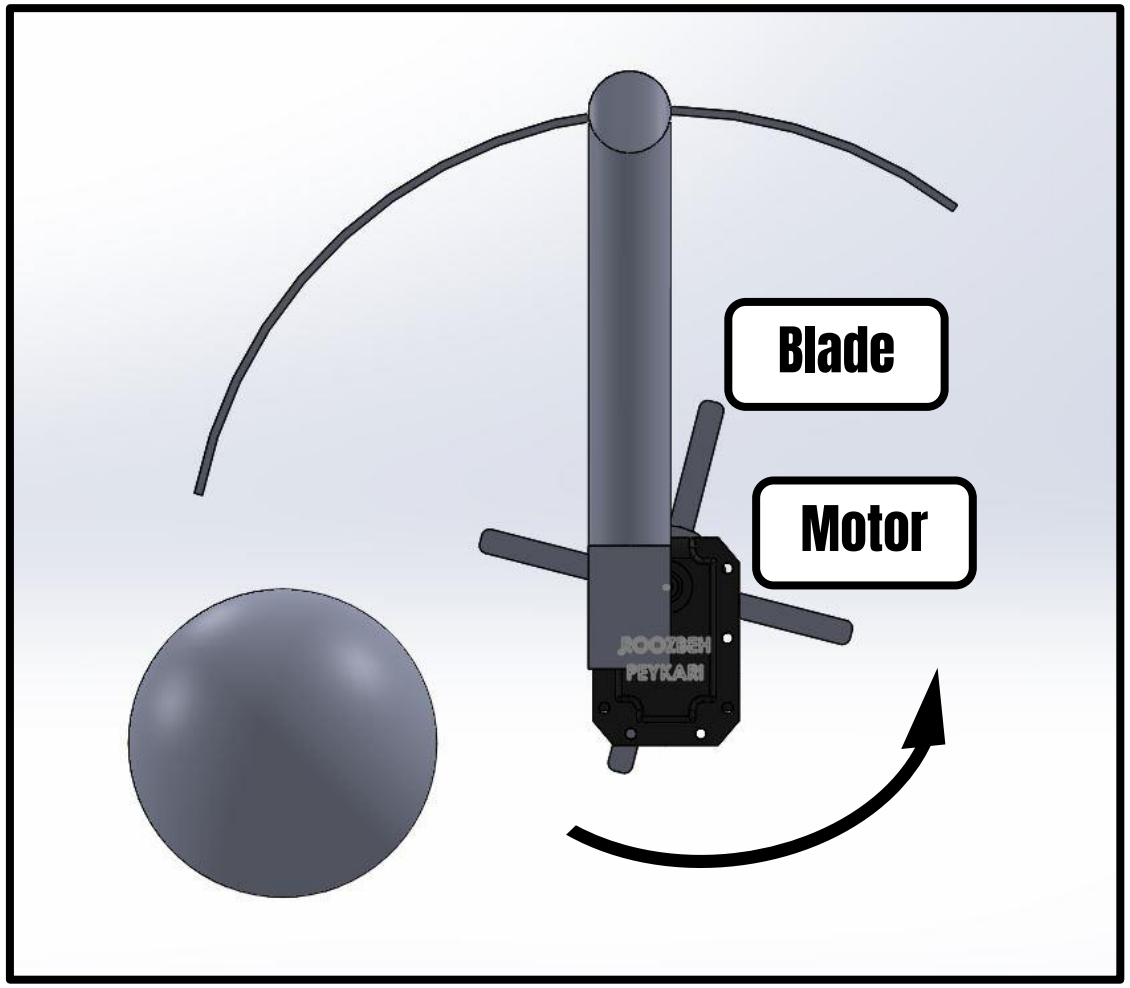
Ball-retrieving mechanism	blade	stamp	catcher	vacuum suction
ability to securely get the ball(not getting lost)	○	○	△	○
easy to produce	○	○	△	X
volume	X	X	△	△
complexity of source code	○	△	△	○
mechanical energy needed	○	△	△	○
creativity	○	△	△	△

Stamp Gripper



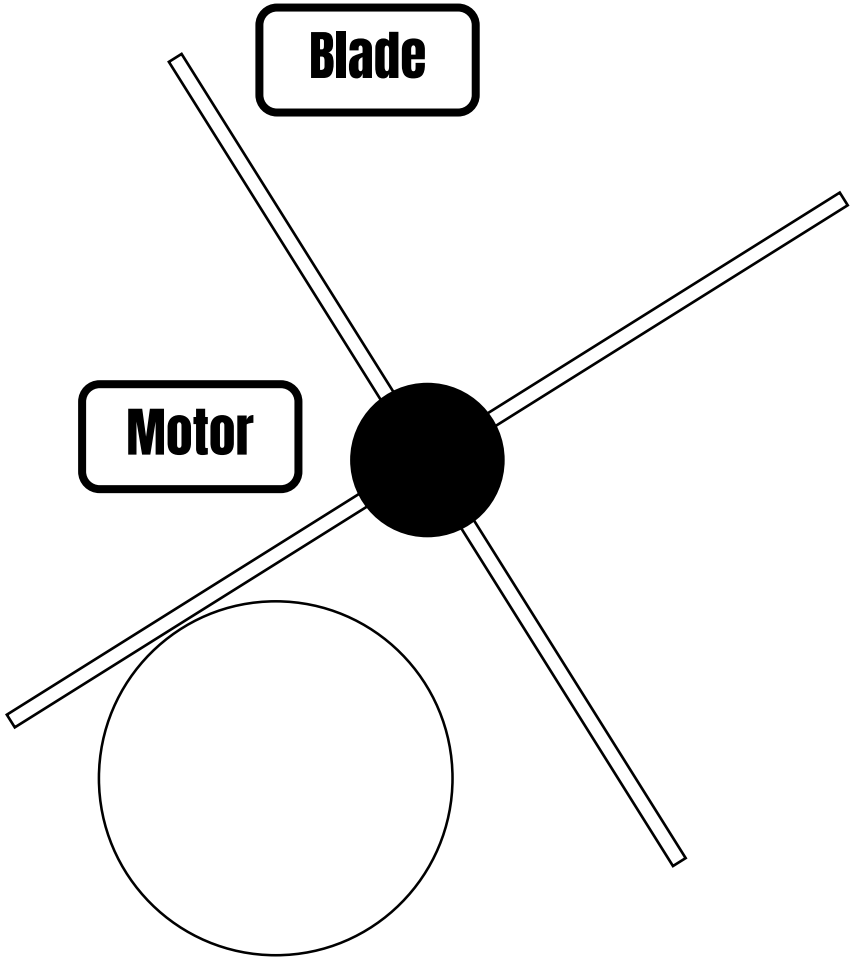
Requires too HIGH accuracy!

Blade Gripper



Rolling Machine – Idea storming
Youtube.com

Blade Gripper



Assumption

1. Ball is rigid.
2. Frictional coefficient between ball and blade and blade and floor are same.
3. Blade and Ball contacts on one point only.

Result

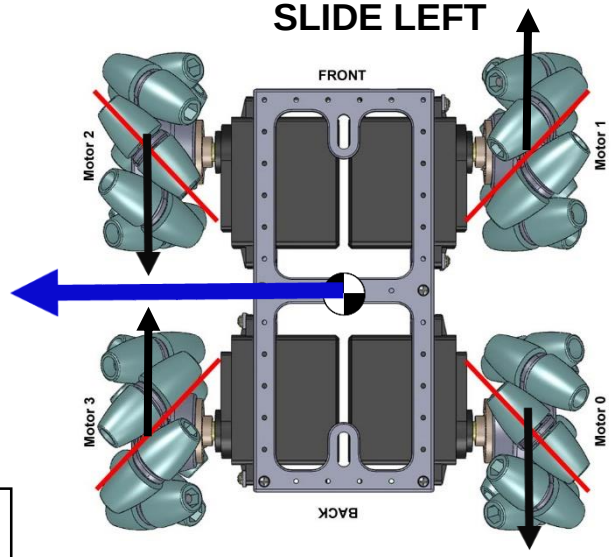
1. We need at least **5.35N** to push the ball.
2. Given Motor's stall sorque is **3.1N*M**
3. We can meet design consideration by using **Aluminum** as blade material

Motor Control

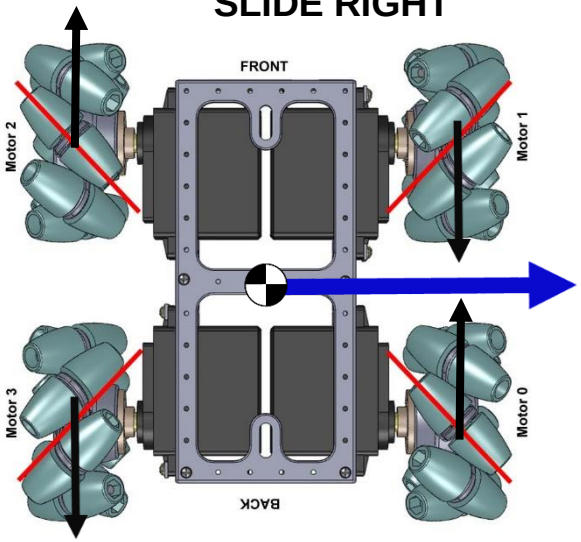
Using Independent motor control for each wheel

Motor/wheel direction
Car direction

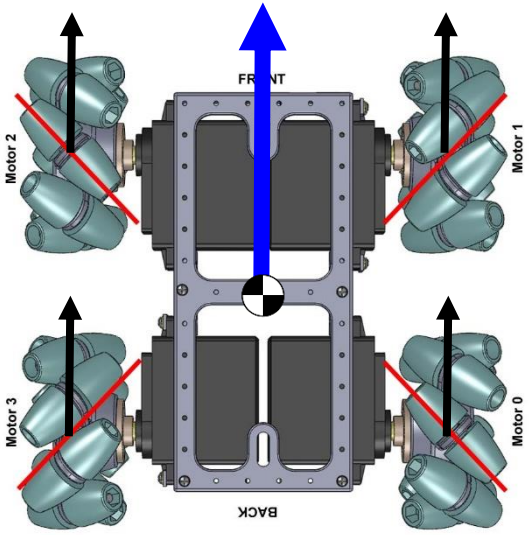
SLIDE LEFT

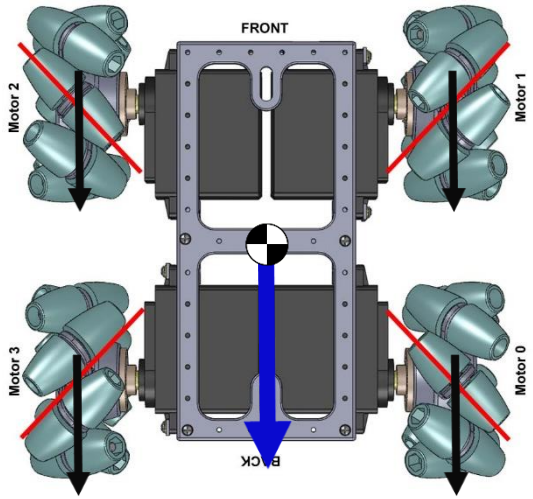


SLIDE RIGHT



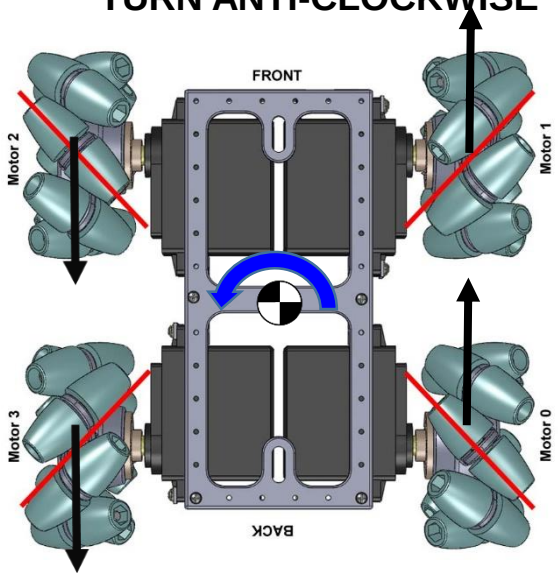
FORWARD



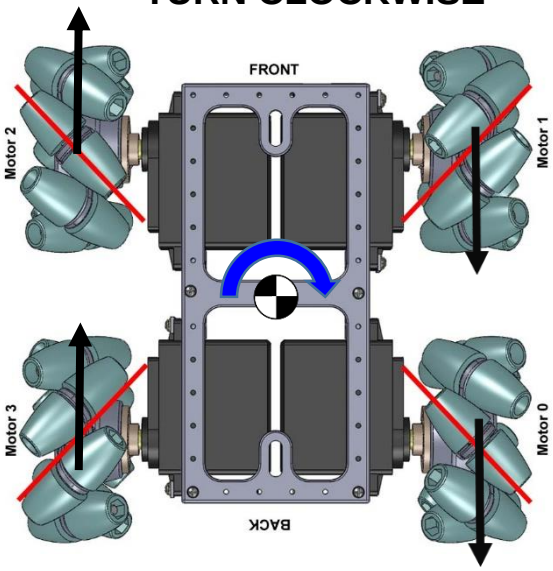


BACKWARD

TURN ANTI-CLOCKWISE

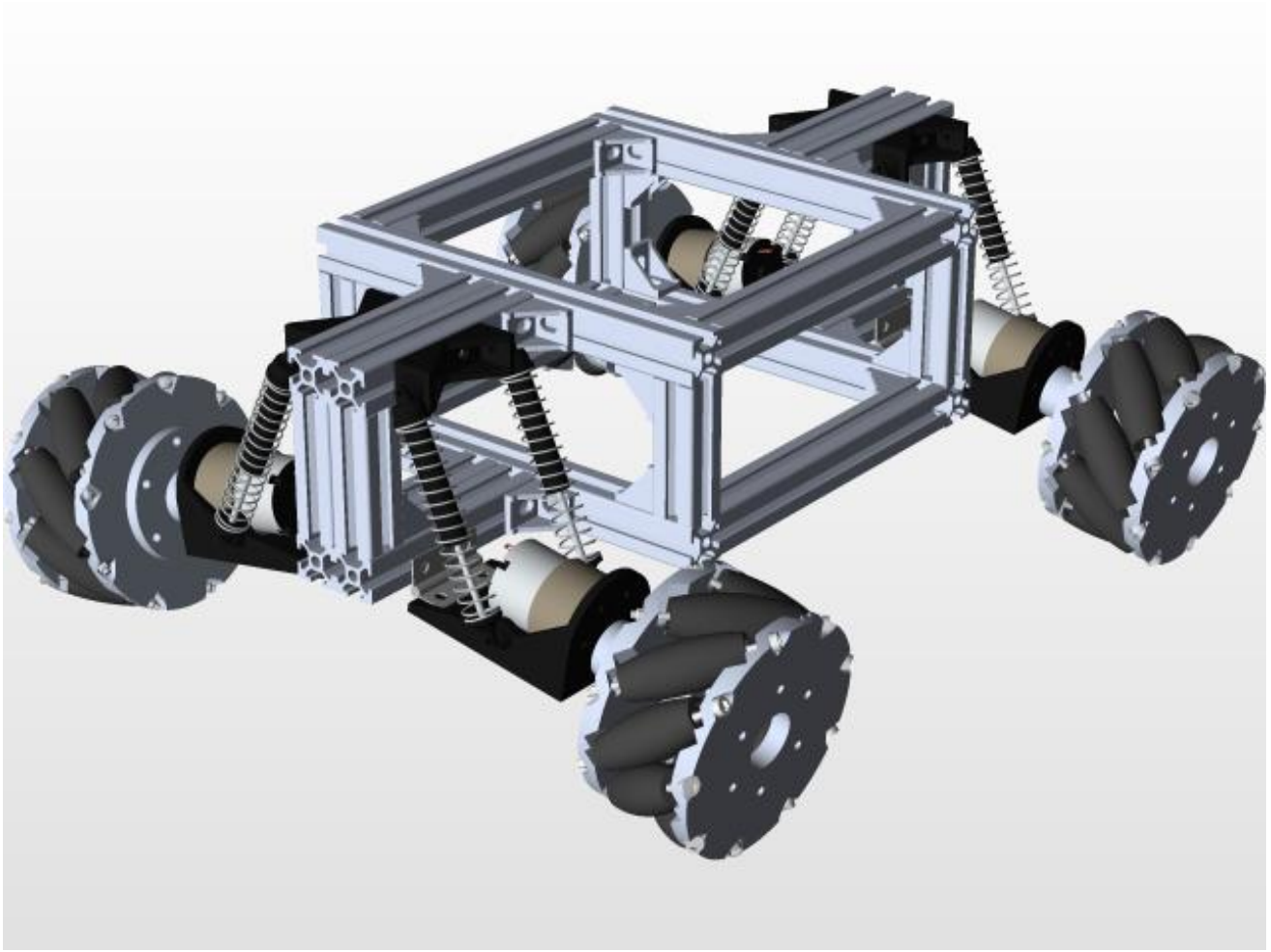


TURN CLOCKWISE

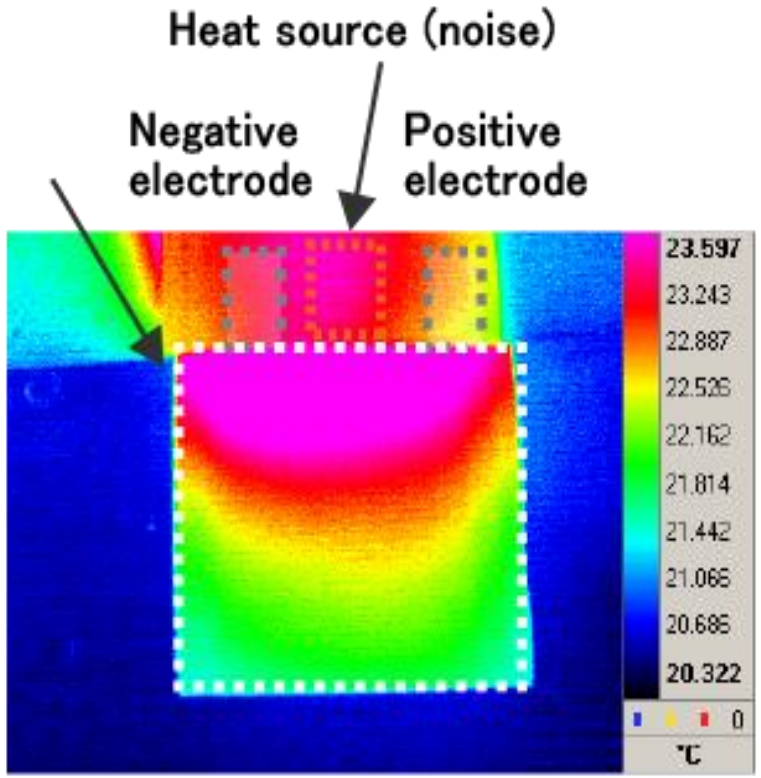


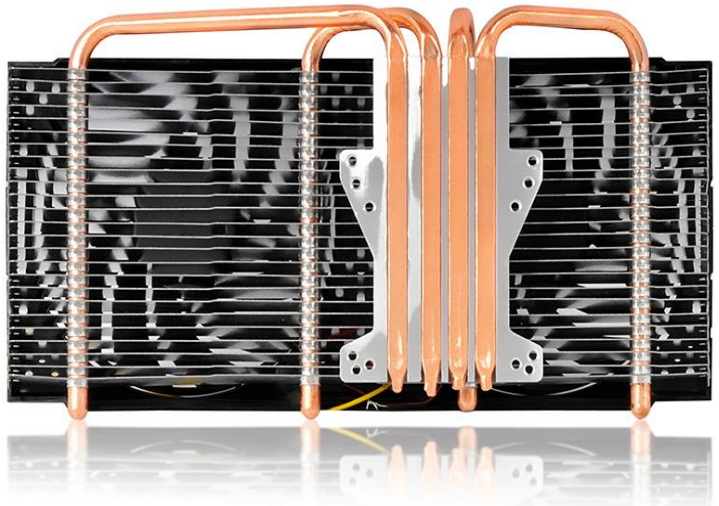
Vibration Reduction

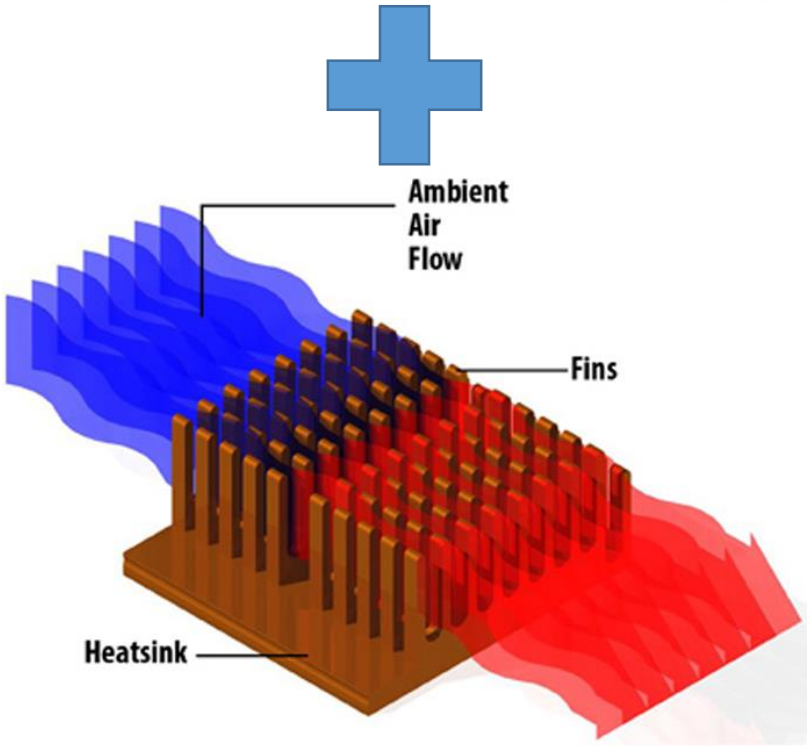
Using Independent axle suspension system



Heat Transfer





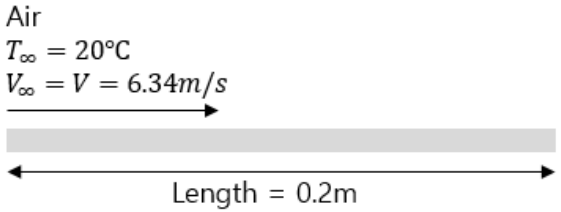


Further...?

1. Make efficient algorithm, collaborate mapping and tracking
2. Test integration of vision and motor
3. Consider using lidar for detection
4. Consider vibration - Camera position

Appendix

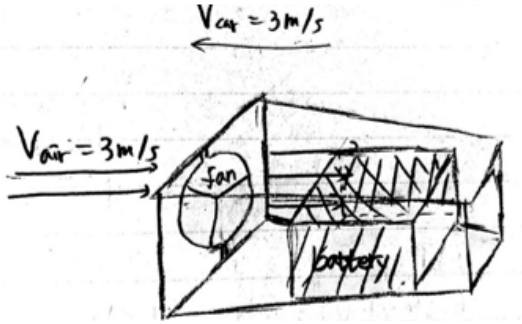
Heat transfer analysis



Use a fan 92x92x20mm fan, maximum air flow is $1.331m^3$/min and input power is 3W.

First I calculate heat emission of battery due to fan. We don't know specs of battery just think it a typical Li-ion battery. In the paper , when battery makes 18.5W (43A, 0.1mΩ), emitted $9560.5W/m^3$ of heat. Our fan needs 3W and battery is $0.003m^3$, our battery will emit 4.8W of heat.

Assume that air passes the battery space with constant speed and car goes with average velocity of 3m/s.



Velocity of air through battery space,
V= 3m/s+$1.331m^3/60s/\pi(0.046)^2m^2$ = 6.34m/s.

Assume that surfaces of battery (10x15x20 cm is flat and calculate heat transfer of 3 plate (ignore front, back and bottom surface.)

Think as a plate, assume $T_\infty = 20°C$, $T_s = 60°C$.
$T_f = 40°C, \rho = 1.165\,kg/m^3$, $Pr = 0.706$,
$k = 27.35\,mw/m \cdot K$, $\nu = 16.92 * 10^{-6}m^2/s$

$Re_L = V_\infty \cdot \frac{L}{\nu} = 7.494 \cdot 10^4$, laminar flow

$\overline{Nu} = \bar{h} \cdot \frac{L}{k} = 0.664Re^{\frac{1}{2}}Pr^{\frac{1}{3}} = 161.86$

$\bar{h} = 22.13\text{W/m}^2 \cdot K$

$\dot{Q} = \bar{h}A(T_s - T_\infty)$, A $= 0.02 \cdot 2 + 0.03 = 0.07$

∴ $\dot{Q}$=62.0W(maximum heat transfer rate of fan)

$\sum\dot{Q}$=57.2W by fan