Mecanum Wheeled Robot Modeling and Path-Following Simulation

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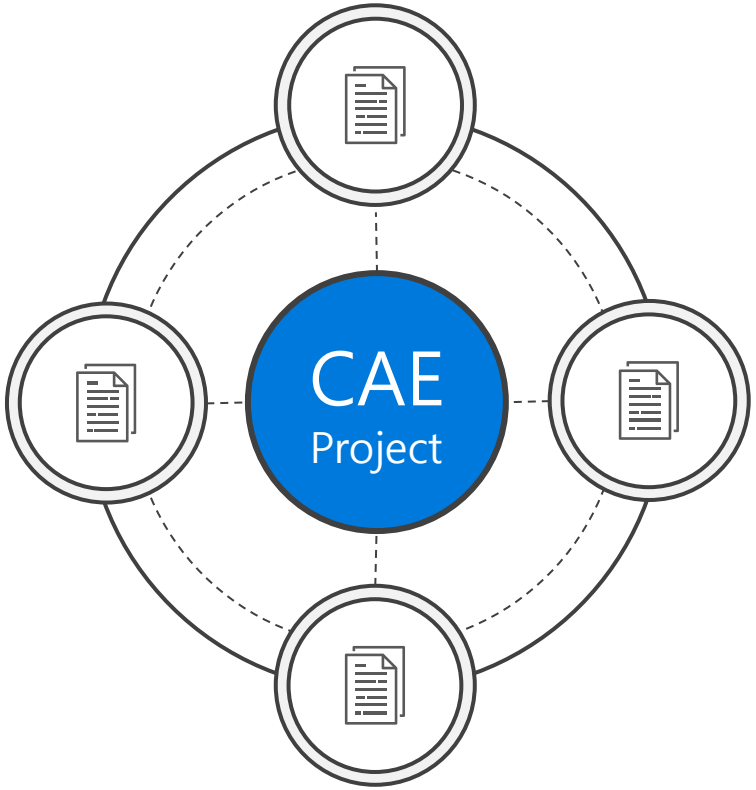
Team - Initial M

Contents

1. Introduction

2. Modeling

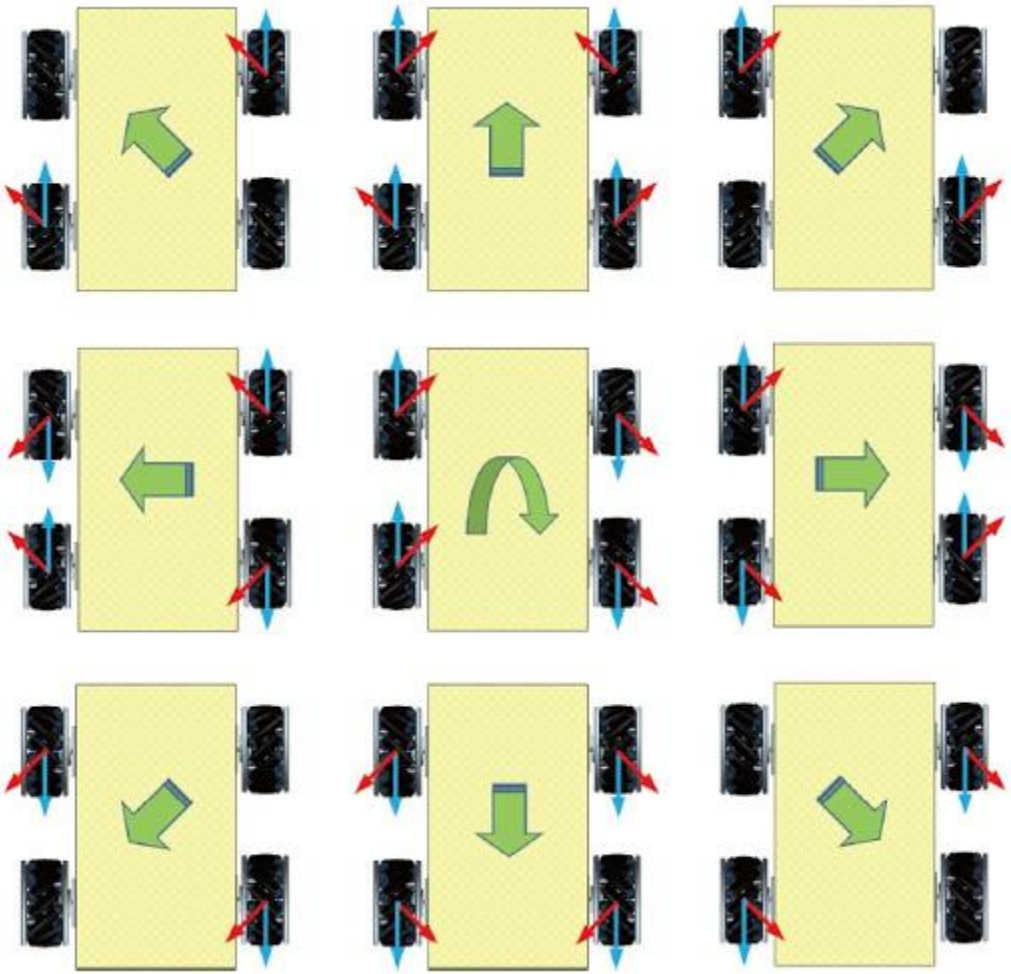


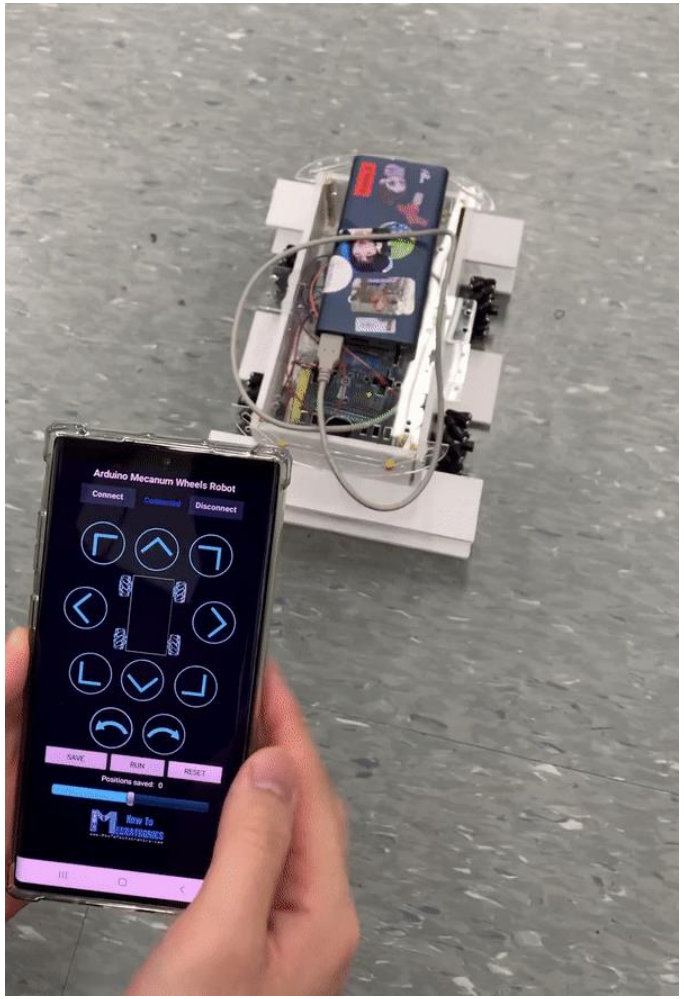
3. Simulink Simulation

4. Q&A

1. Introduction

- 주제 선정 배경





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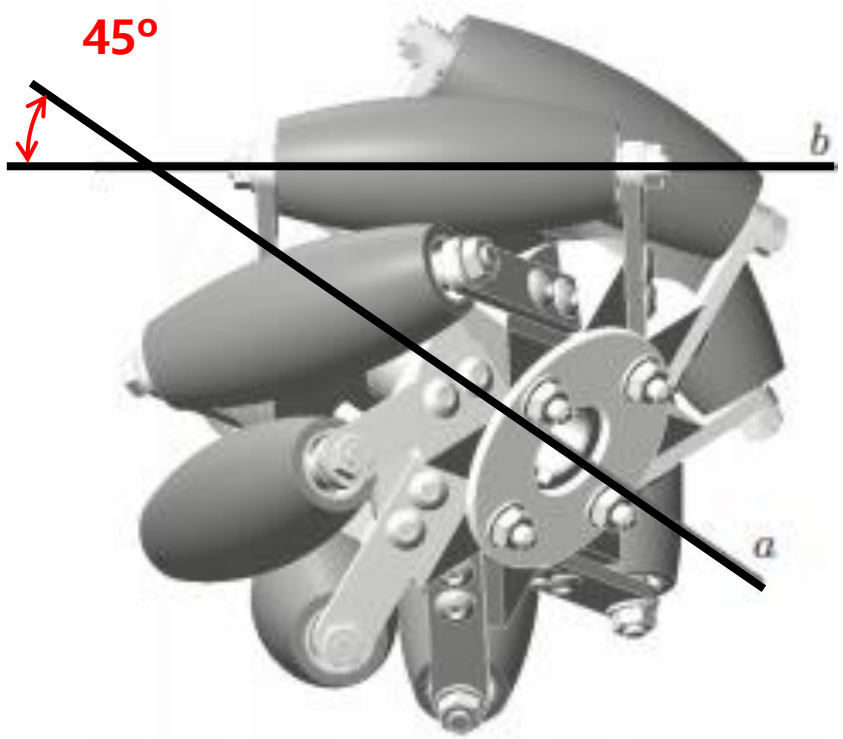
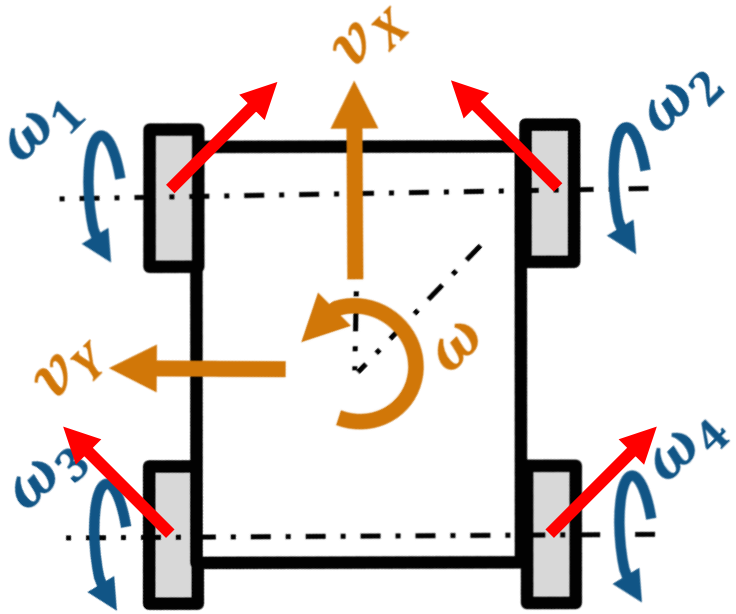
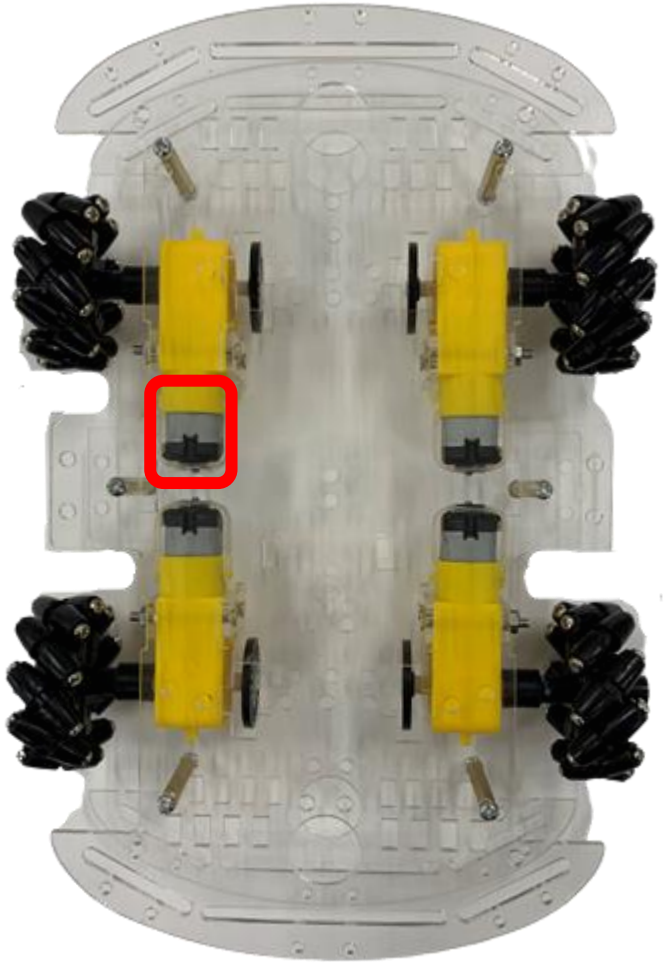
1. Introduction

- *Mecanum Wheel*





2. Modeling



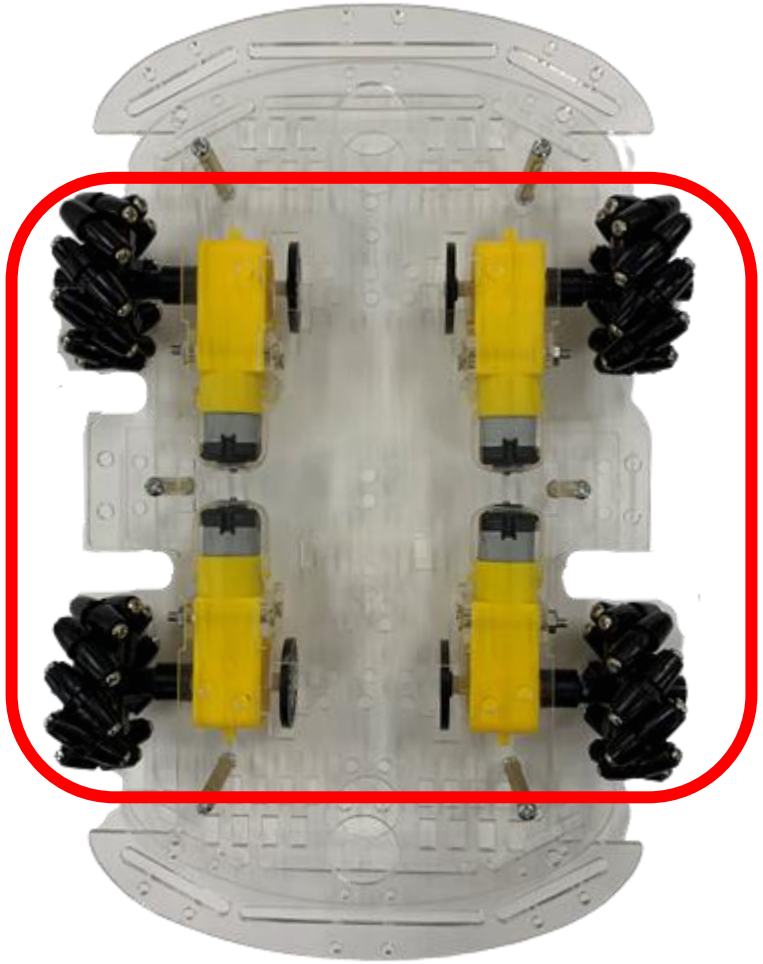
(1) PMDC motor with controller

(2) Powertrain model

(3) Kinematic model

(4) Pure pursuit algorithm

2. Modeling



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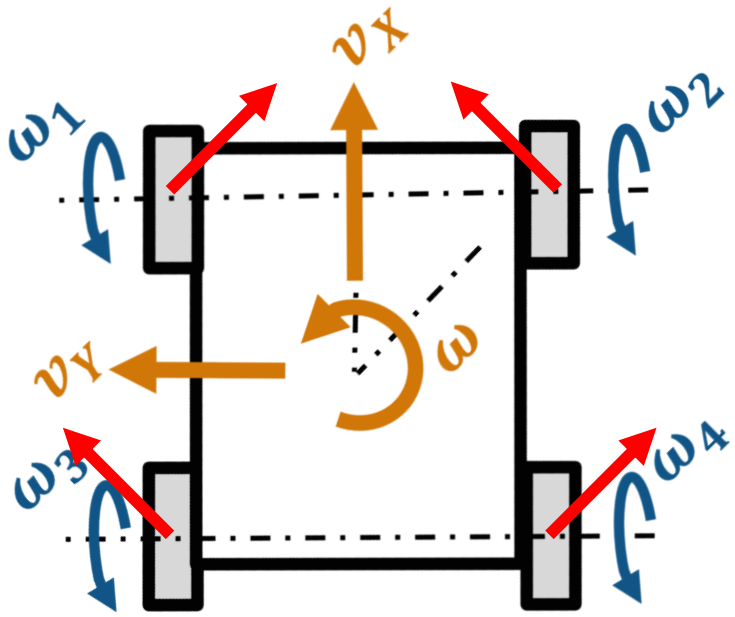

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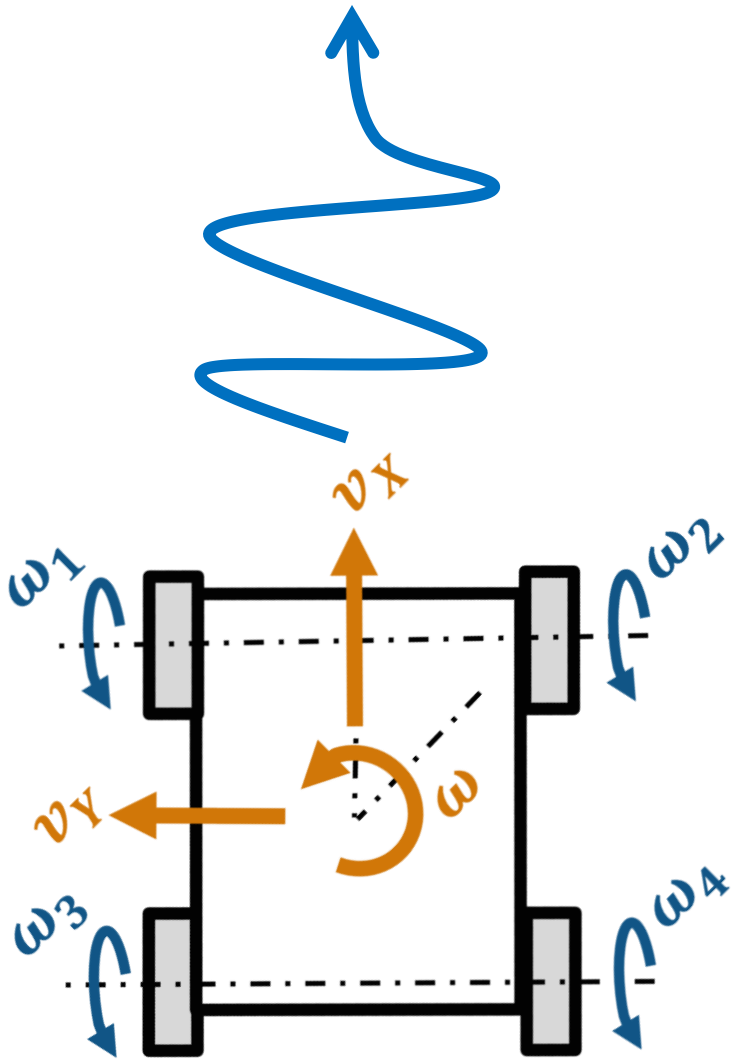

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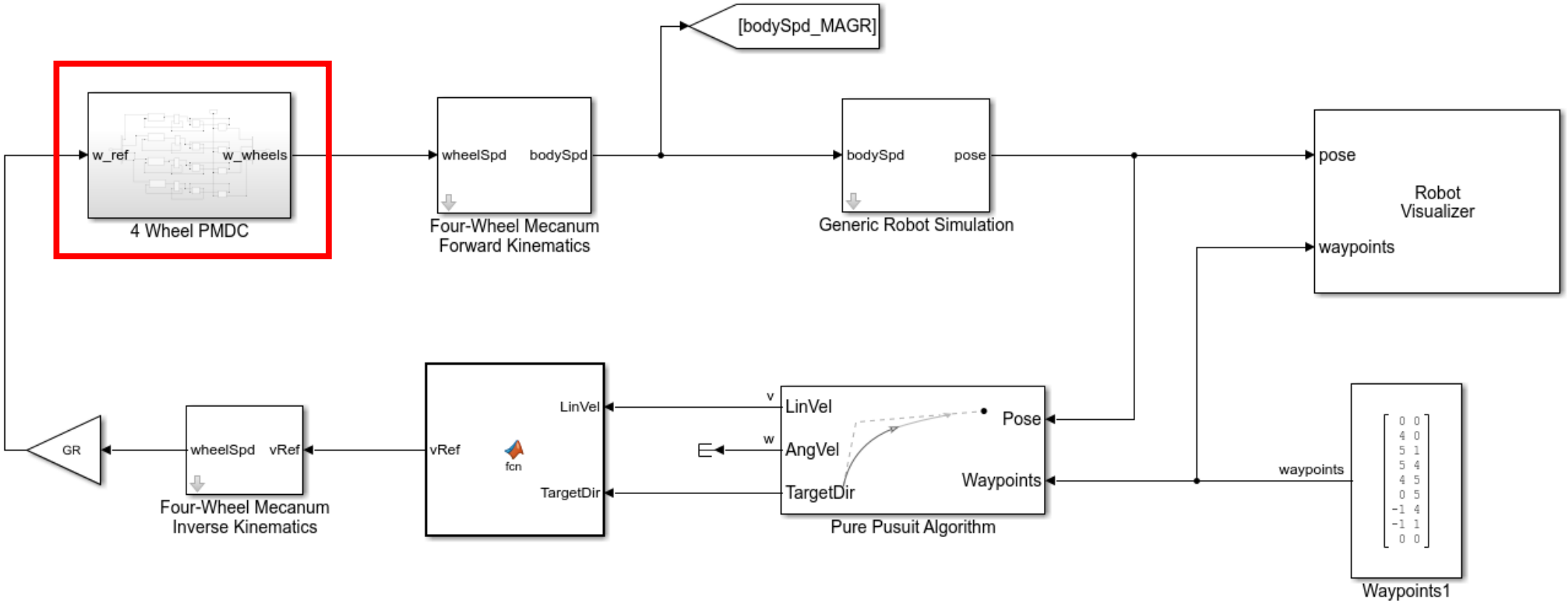
2. Modeling

– *PMDC Motor with Controller Modeling*



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2. Modeling

– PMDC Motor with Controller Modeling

DC-max 16 S Ø16mm, 메탈 브러시 CLL, 볼 베어링

정격 전압에서의 값	
정격 전압	6 V
무부하 속도	7890 rpm
무부하 전류	14.8 mA
정격 속도	4840 rpm
정격 토크 (최대 연속 토크)	4.04 mNm
정격 전류 (최대 연속 전류)	0.575 A
정지 토크	10.5 mNm
정지 전류	1.46 A
최대 효율	81 %
특성	
단자 저항	4.1 Ω
단자 인덕턴스	0.14 mH
토크 상수	7.19 mNm/A
속도 상수	1330 rpm/V
속도/토크 기울기	758 rpm/mNm
기계적 시상수	8.87 ms
로터 관성	1.12 gcm²

[PMDC Motor Specs]

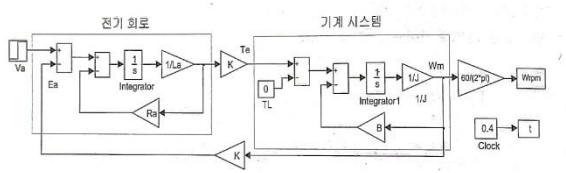

그림 2.56 전동기 모델과 부하 시스템 모델의 결합

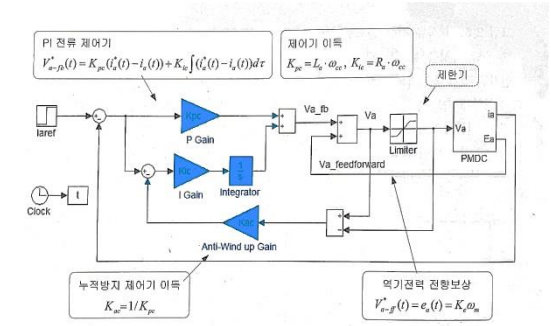

그림 2.59 비례적분 전류 제어기가 포함된 전체 구동시스템의 모델

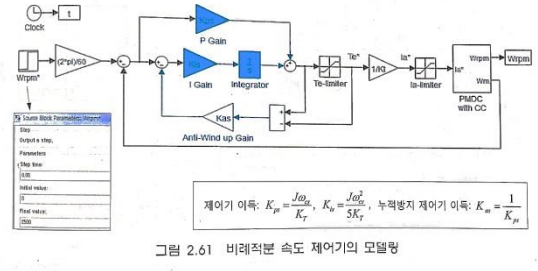

그림 2.61 비례적분 속도 제어기의 모델링

[PMDC Motor 제어기]

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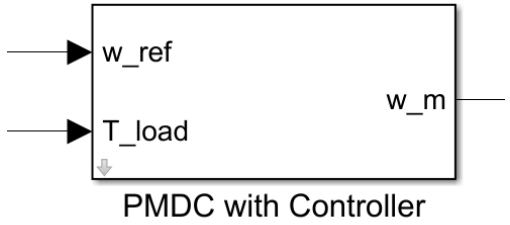
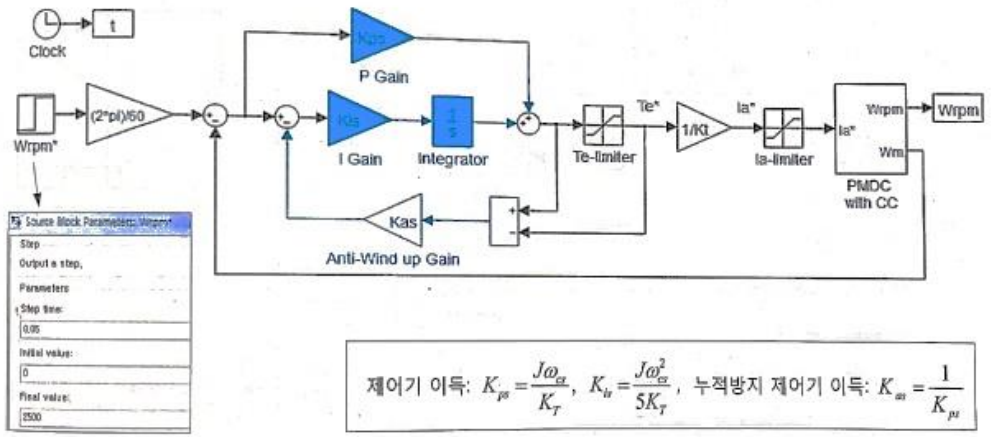
2. Modeling

– *PMDC Motor with Controller Modeling*





제어기 이득: $K_{ps}=\frac{J\omega_{cs}}{K_T}$, $K_{is}=\frac{J\omega_{cs}^2}{5K_T}$, 누적방지 제어기 이득: $K_{as}=\frac{1}{K_{ps}}$

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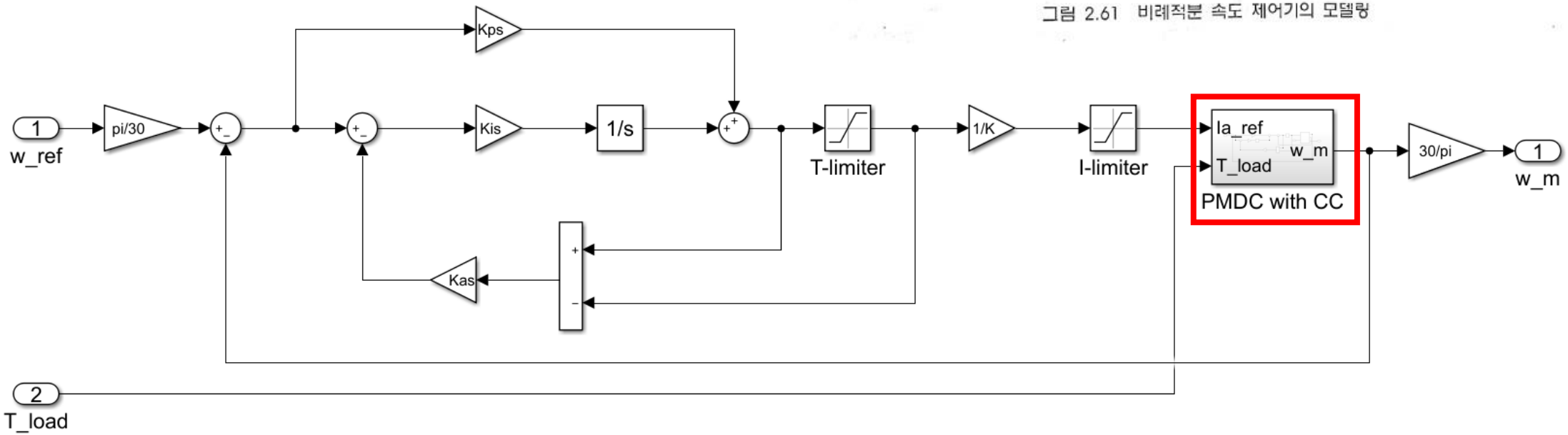
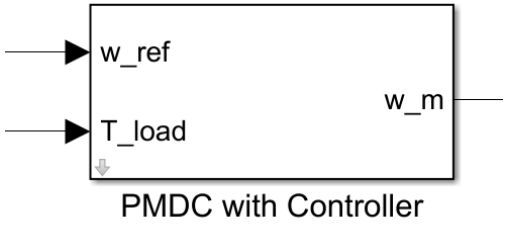
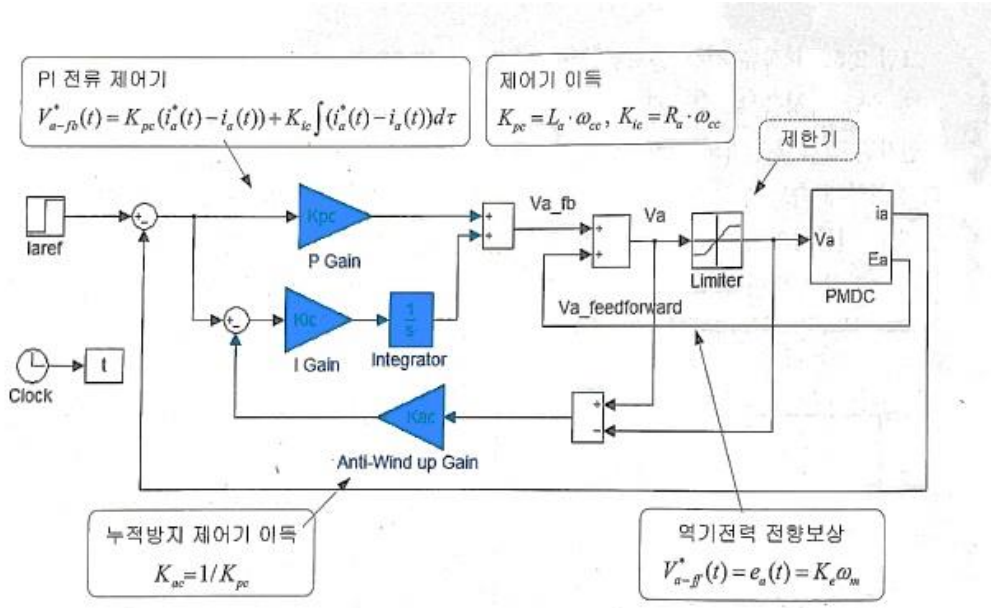


Team - Initial M

2. Modeling

– PMDC Motor with Controller Modeling





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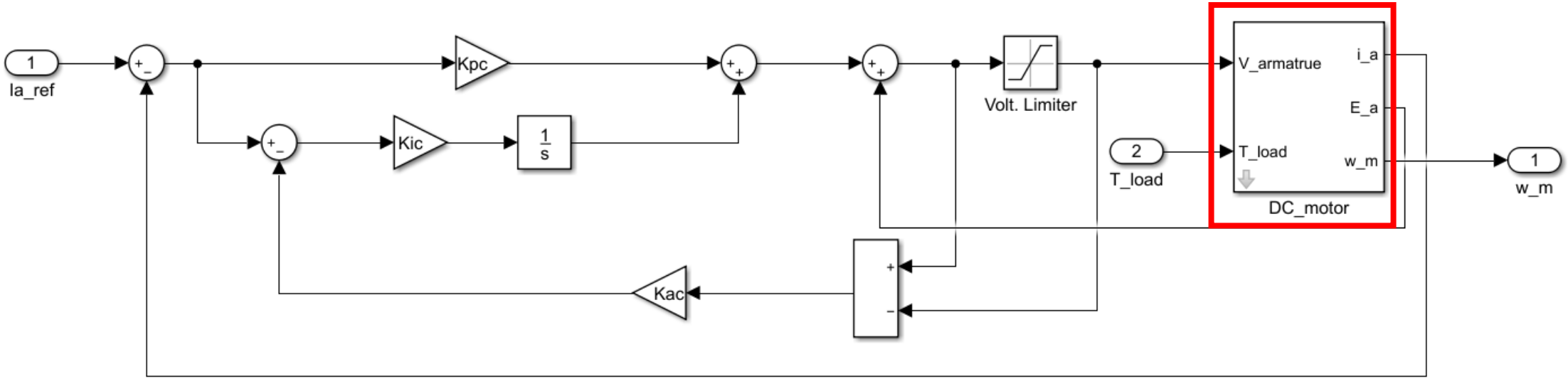
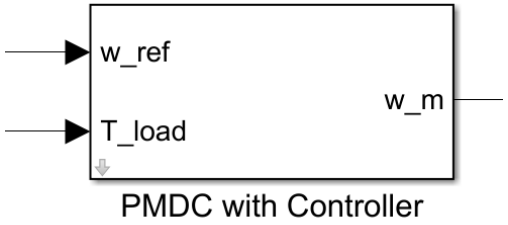
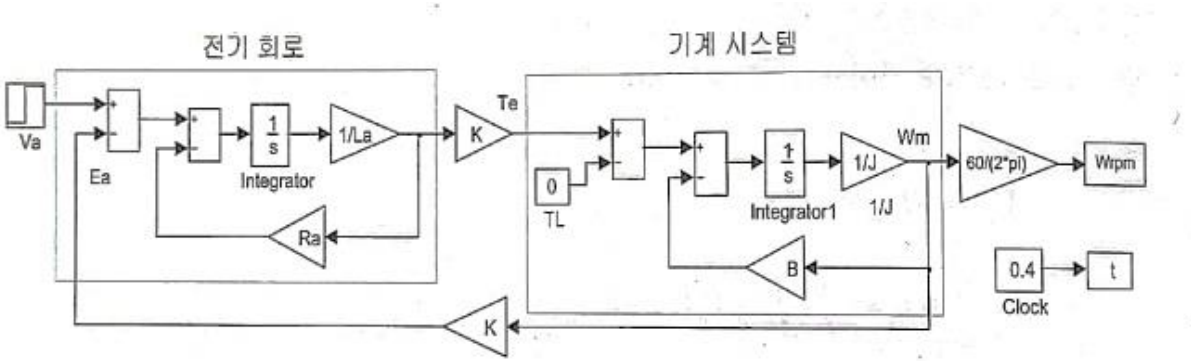


Team - Initial M

2. Modeling

– PMDC Motor with Controller Modeling





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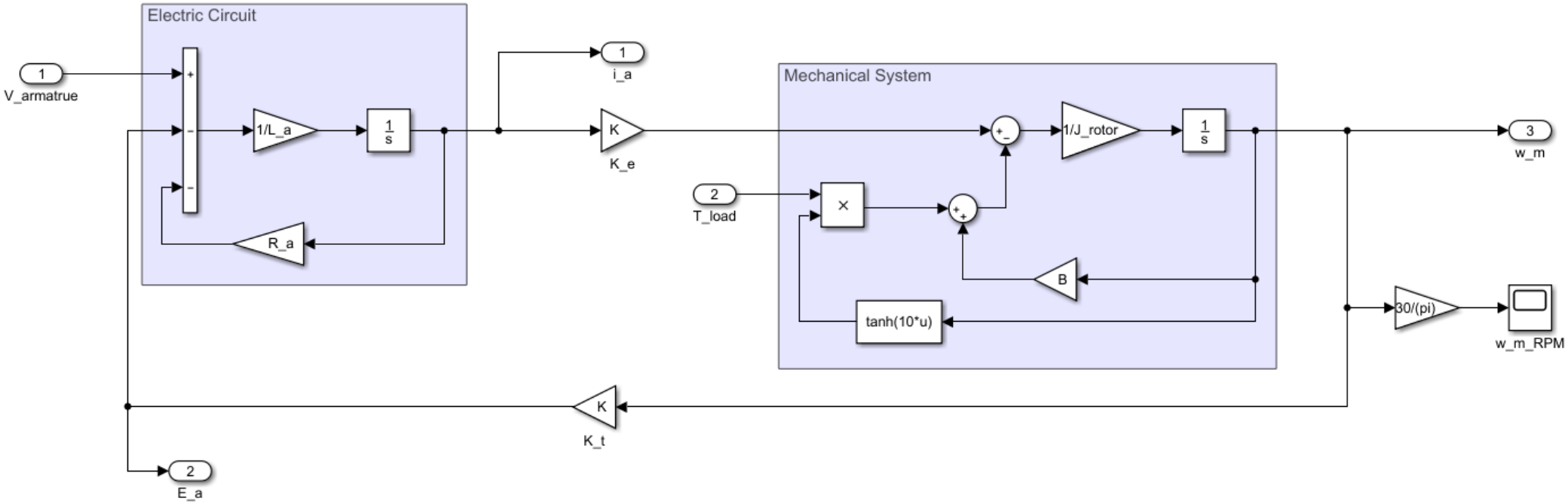

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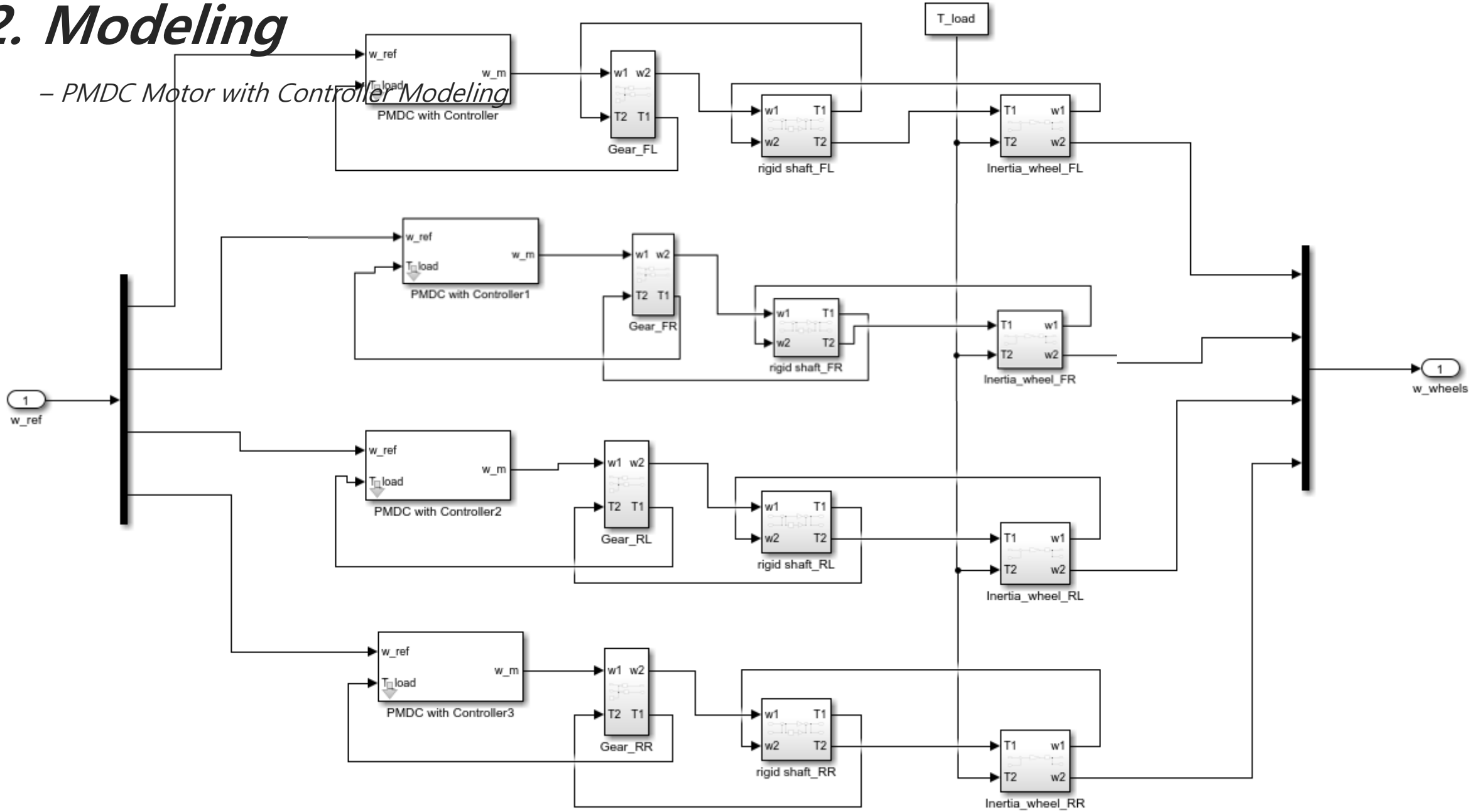
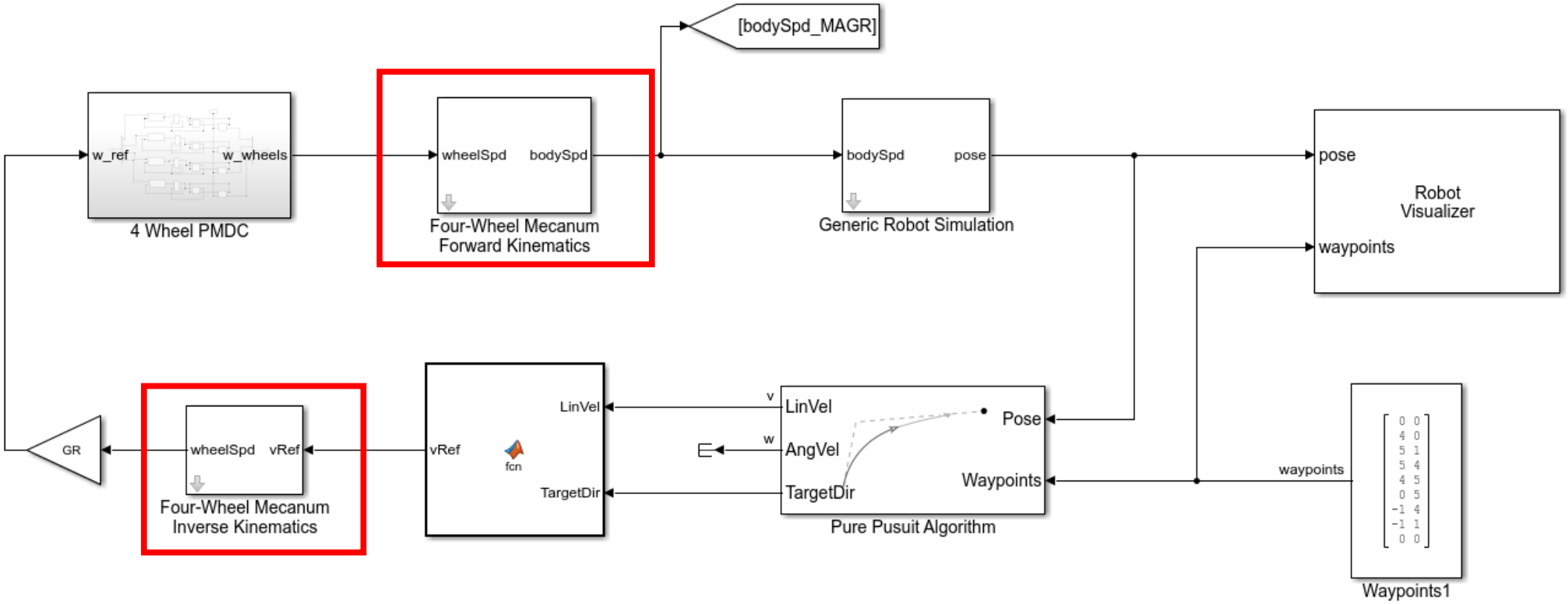
2. Modeling

– *PMDC Motor with Controller Modeling*



2. Modeling

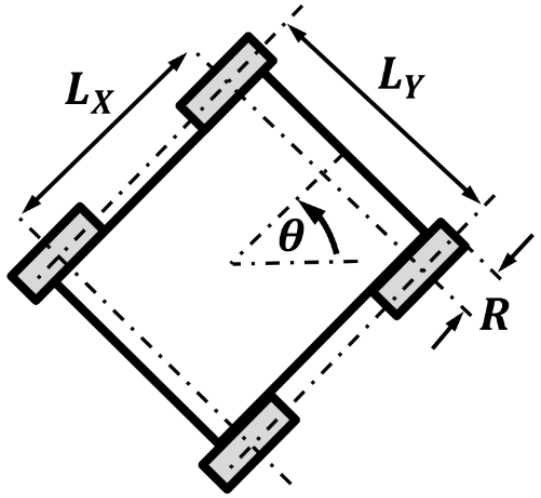
– *Kinematic Modeling*

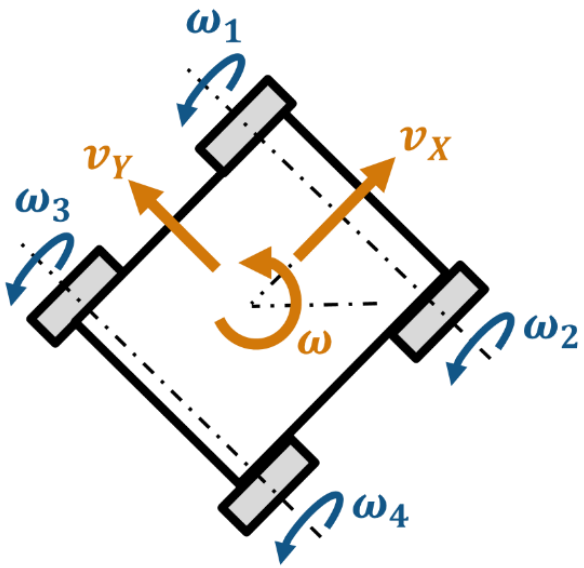


Team - Initial M

2. Modeling

– Kinematic Modeling





Wheel Speed → $\omega_1, \omega_2, \omega_3, \omega_4$

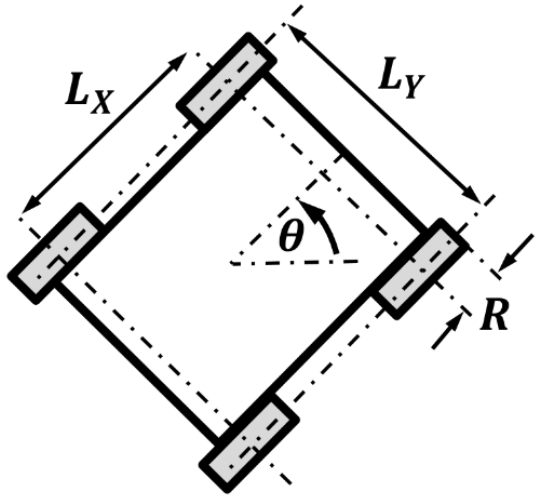
Body Speed → v_x, v_y, ω

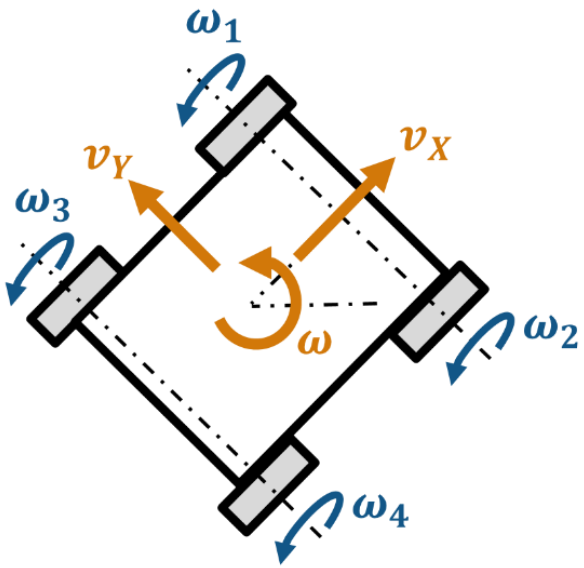
Forward Kinematics Matrix

$$\begin{bmatrix} v_x \\ v_y \\ \omega \end{bmatrix} = \frac{R}{4}\begin{bmatrix} 1 & 1 & 1 & 1 \\ -1 & 1 & 1 & -1 \\ \dfrac{-2}{(L_x + L_y)} & \dfrac{2}{(L_x + L_y)} & \dfrac{-2}{(L_x + L_y)} & \dfrac{2}{(L_x + L_y)} \end{bmatrix}\begin{bmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \end{bmatrix} \quad (1)$$

2. Modeling

– *Kinematic Modeling*





Body Speed → v_x, v_y, ω

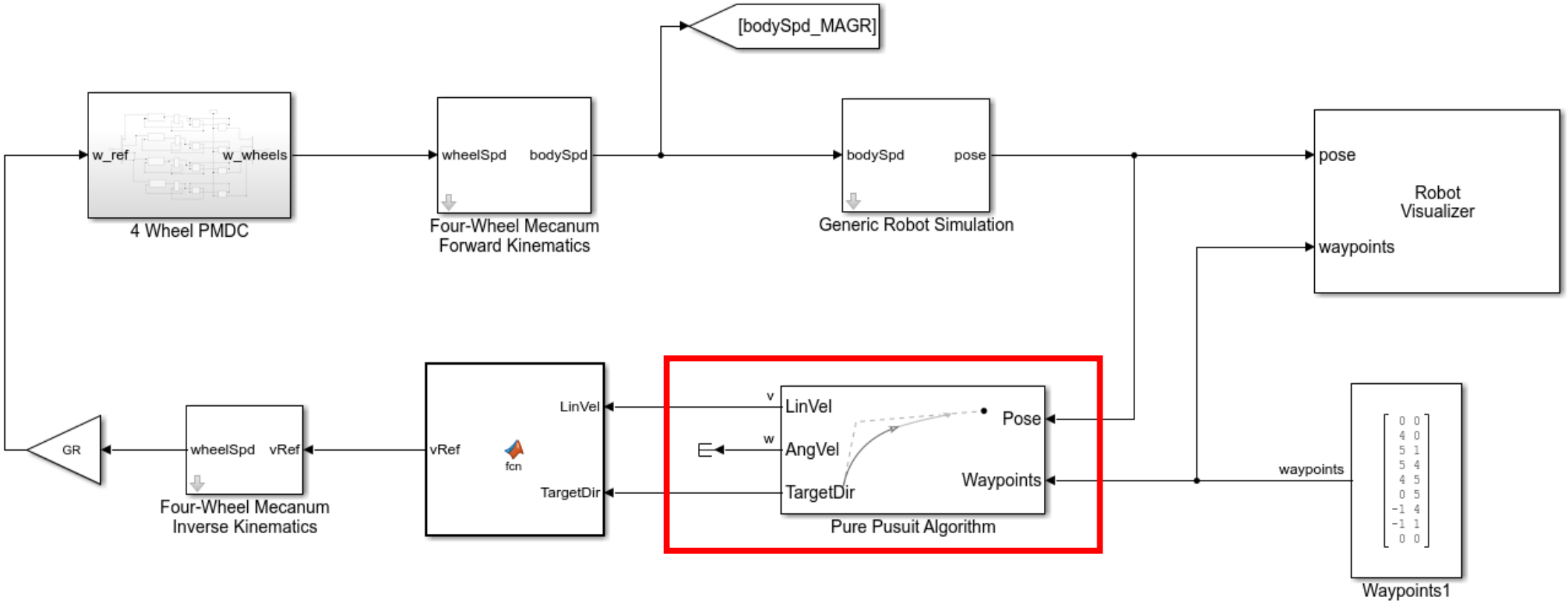
Wheel Speed → $\omega_1, \omega_2, \omega_3, \omega_4$

Inverse Kinematics Matrix

$$\begin{bmatrix}\omega_1\\ \omega_2\\ \omega_3\\ \omega_4\end{bmatrix} = \frac{1}{R}\begin{bmatrix}1 & -1 & -(L_x+L_y)/2\\ 1 & 1 & (L_x+L_y)/2\\ 1 & 1 & -(L_x+L_y)/2\\ 1 & -1 & (L_x+L_y)/2\end{bmatrix}\begin{bmatrix}v_x\\ v_y\\ \omega\end{bmatrix}$$

2. Modeling

– Pure Pursuit Algorithm



Team - Initial M

2. Modeling

– Pure Pursuit Algorithm

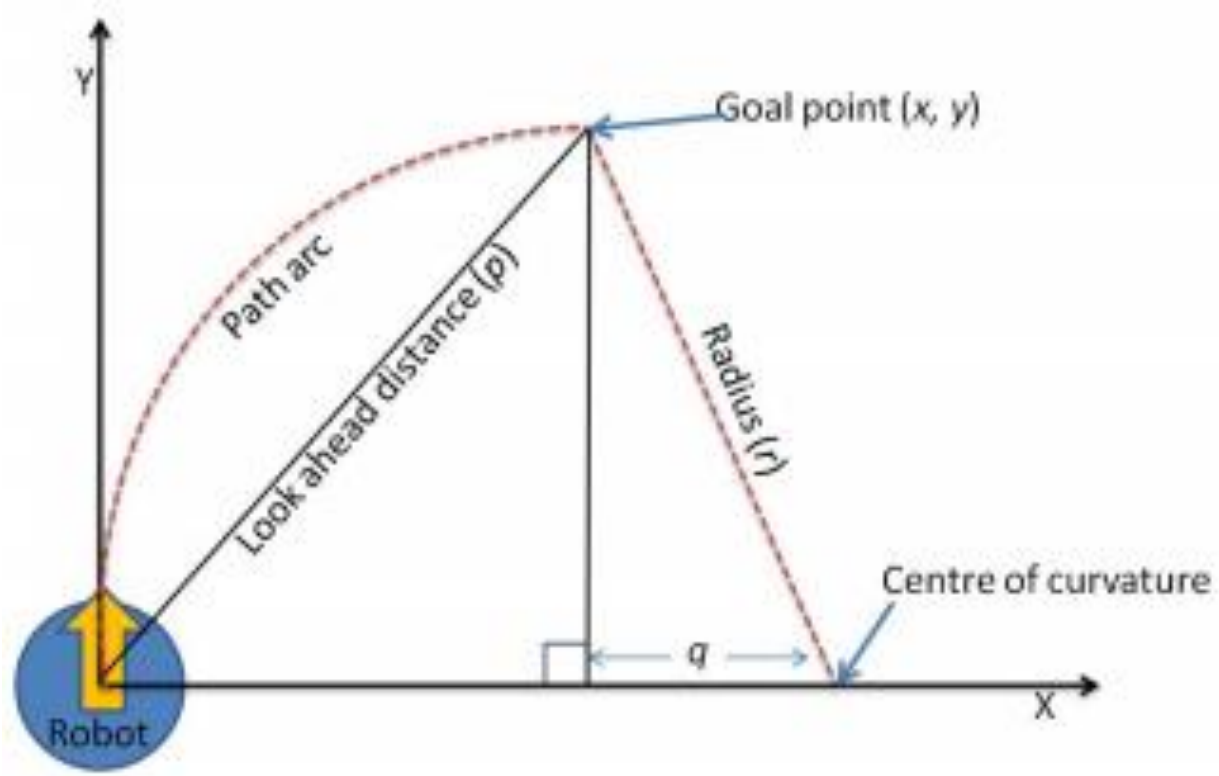


Figure 1: Geometry of the pure pursuit algorithm.

Start Point → Goal Point

$$x^2 + y^2 = p^2$$

$$x + q = r$$

$$q = r - x$$

$$q^2 + y^2 = p^2$$

$$(r-x)^2 + y^2 = r^2$$

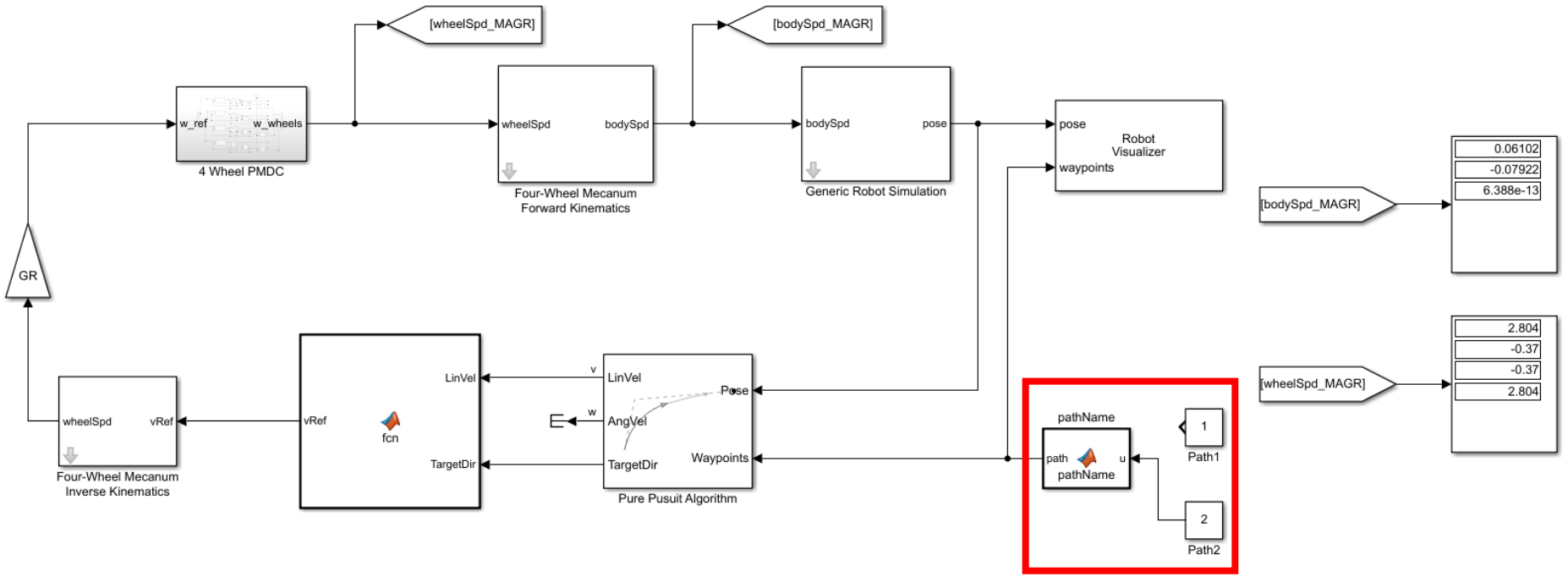
$$r^2 - 2rx + x^2 + y^2 = r^2$$

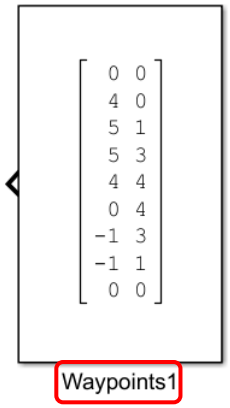
$$2rx = p^2$$

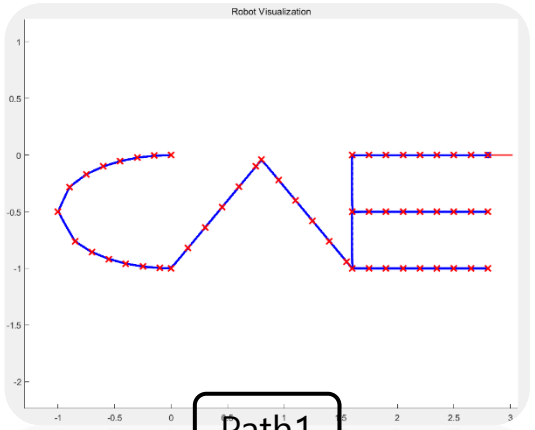
$$\rho = \frac{1}{r} = \frac{2x}{p^2}$$

3. Simulation

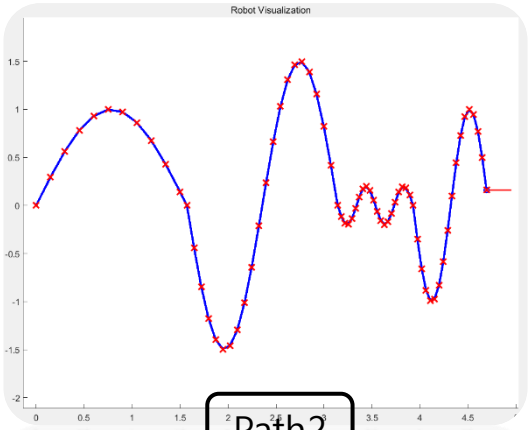
– Mecanum Wheel Robot







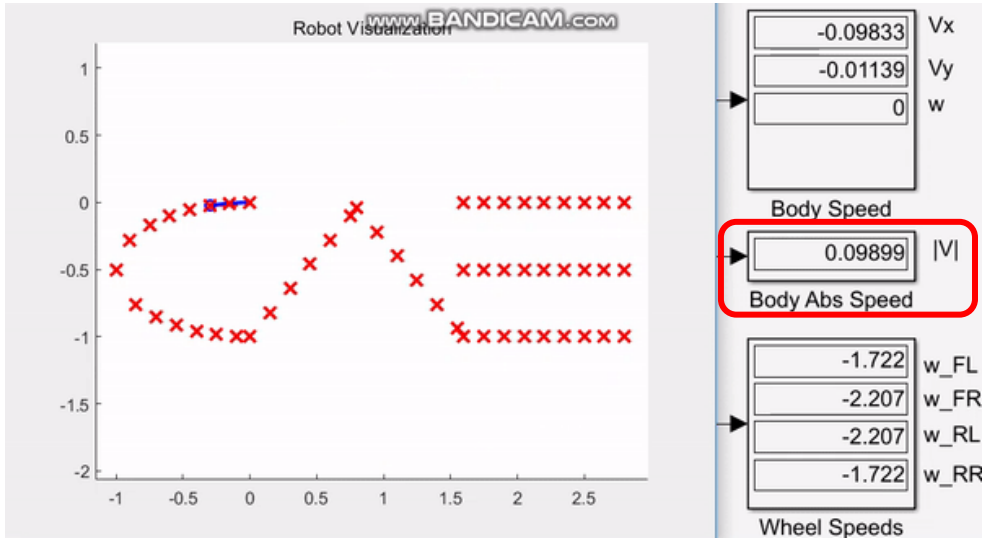
OR

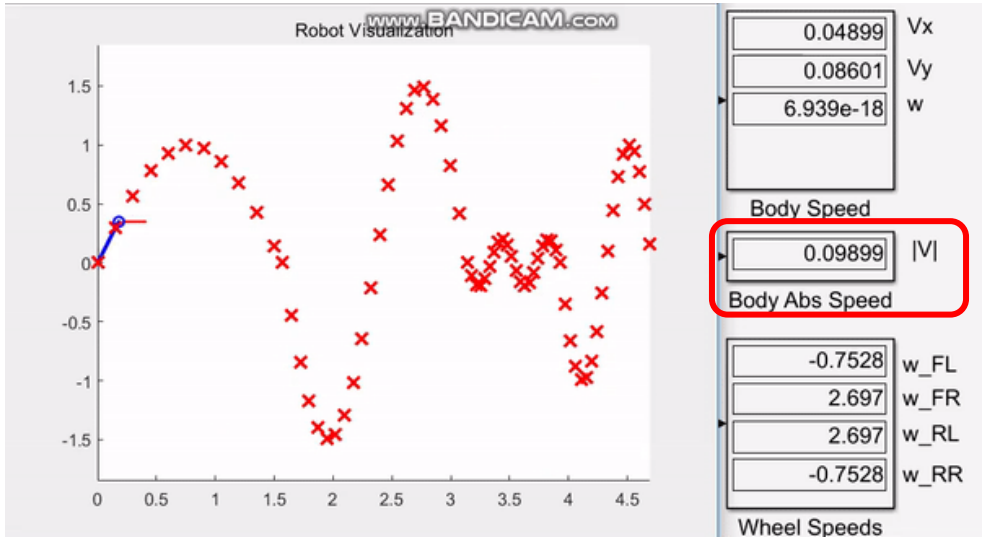


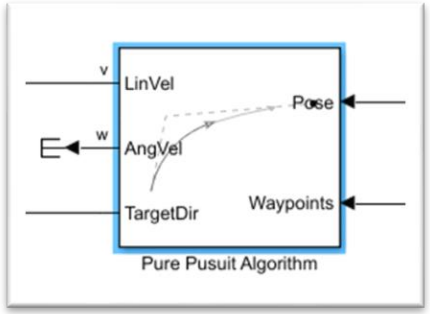
Team - Initial M

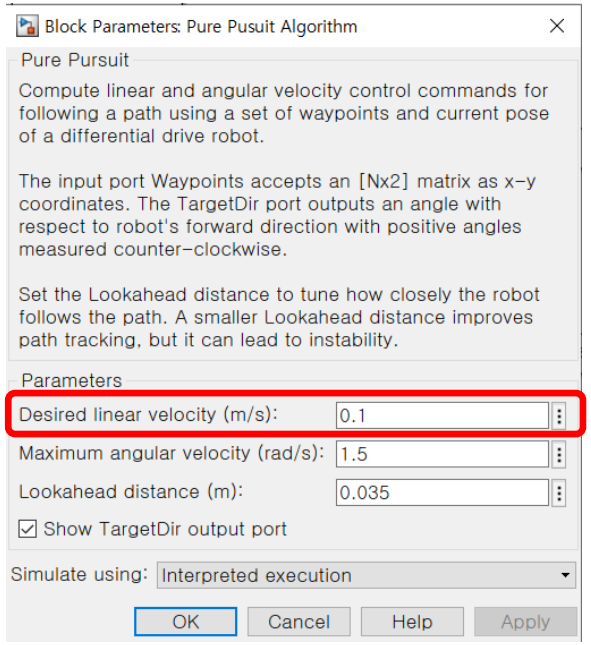
3. Simulation

– *Mecanum Wheel Robot*









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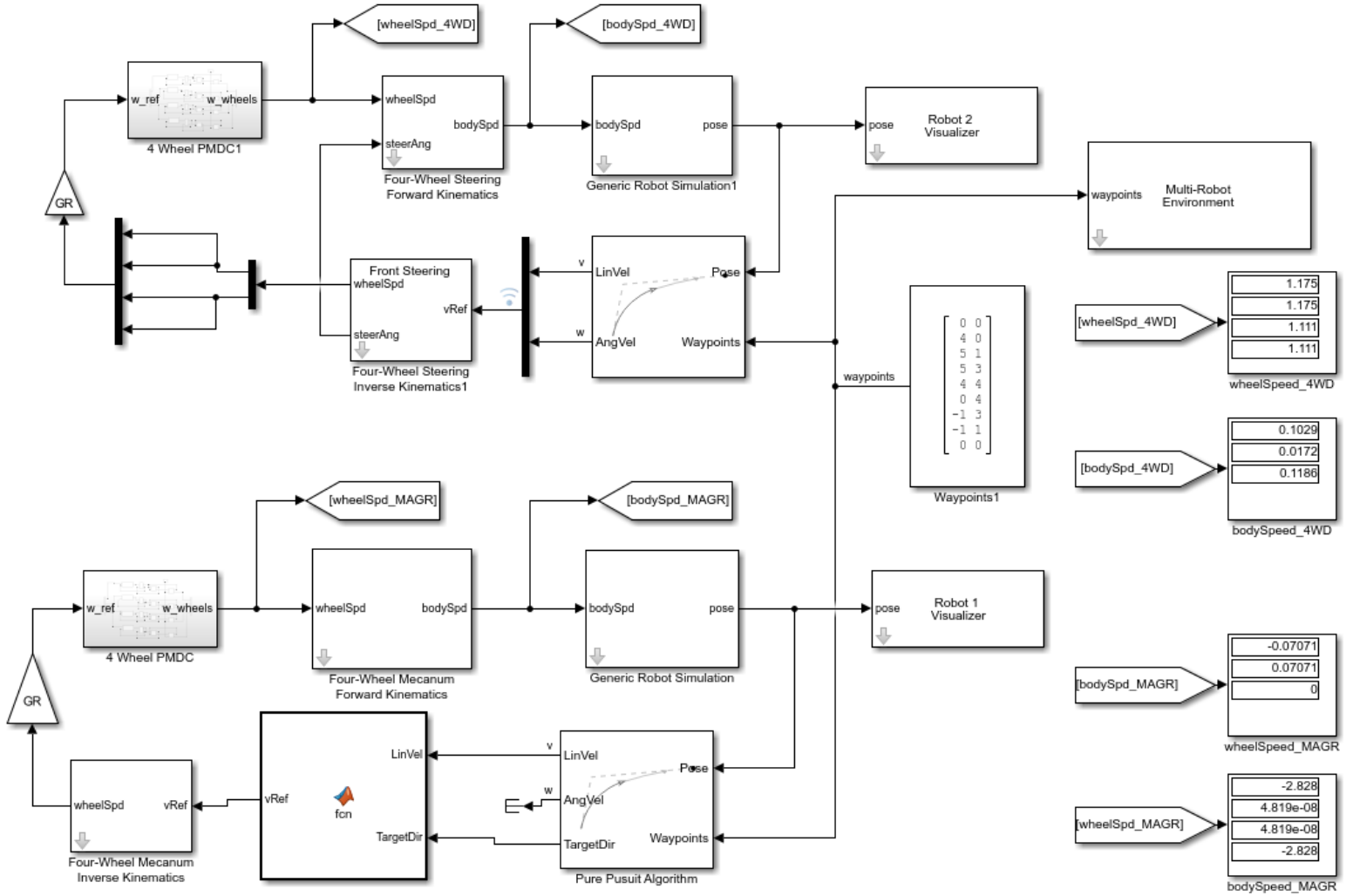
3. Simulation

– Mecanum Wheel Model vs Steering Model



Team - Initial M

3. Simulation

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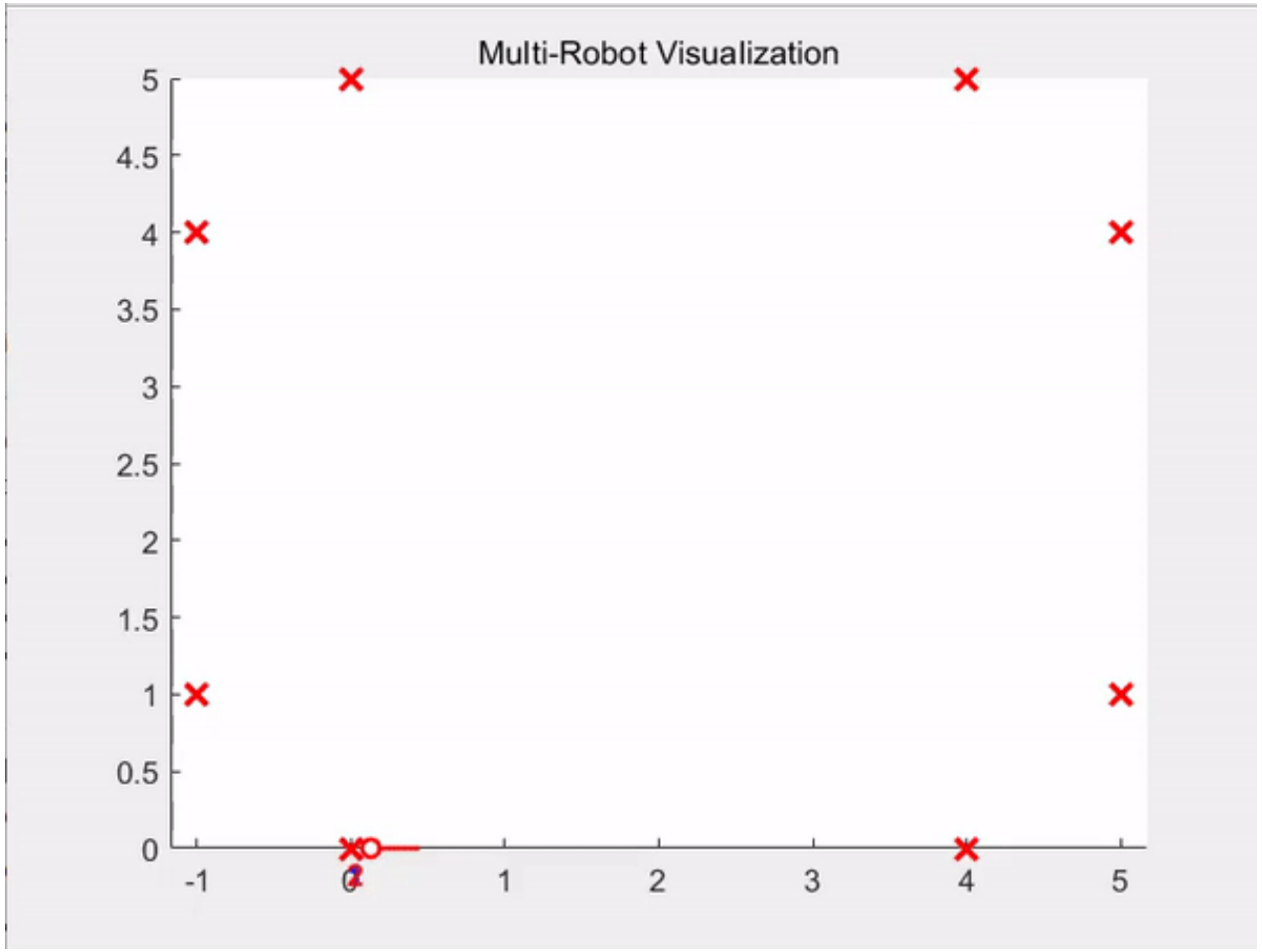

1. Mecanum Wheel Model

2. Steering Model

Q&A

References

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