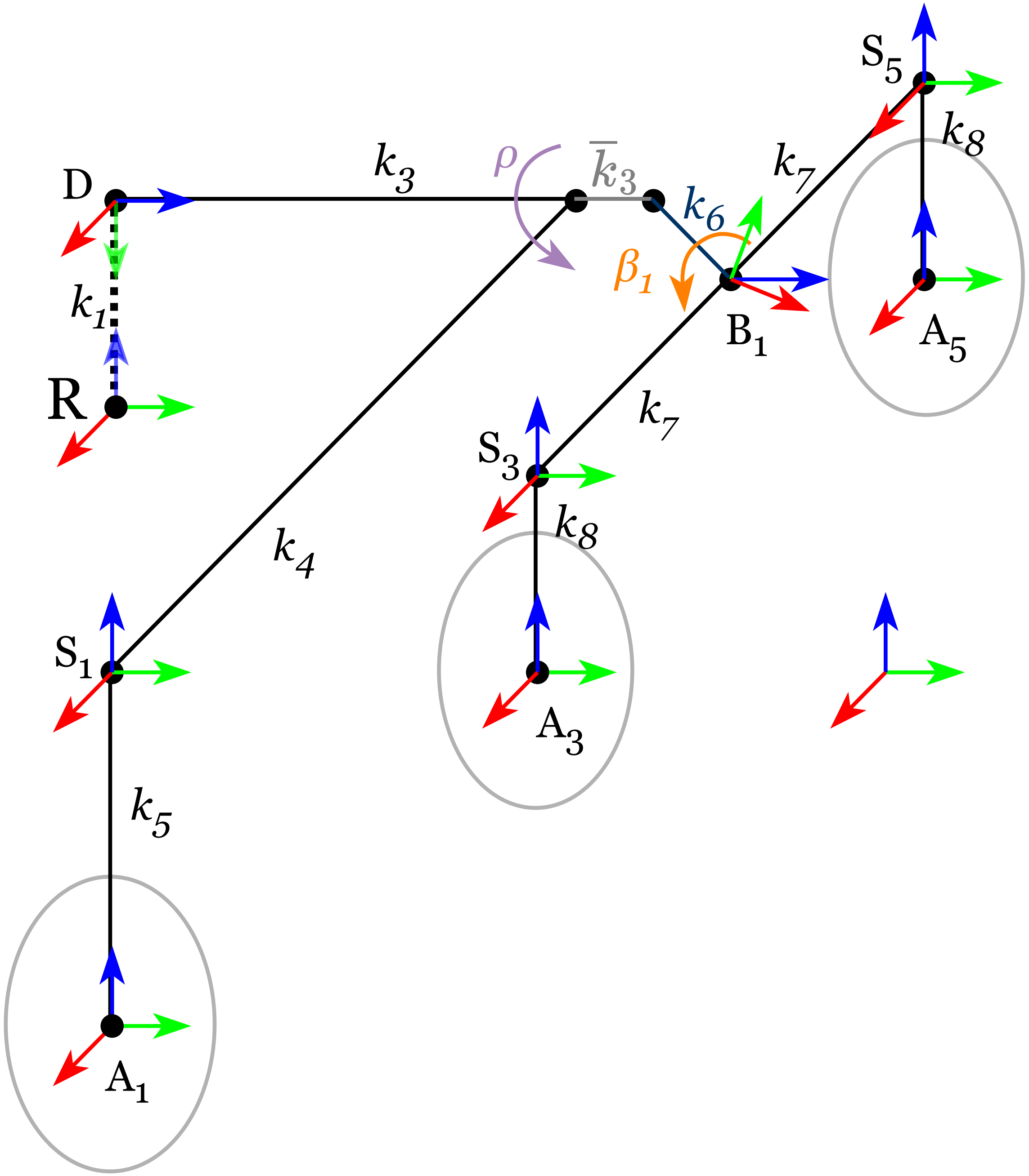
Kinematic Modeling and Control of a Six-Wheel Planetary Rover with Front Steering

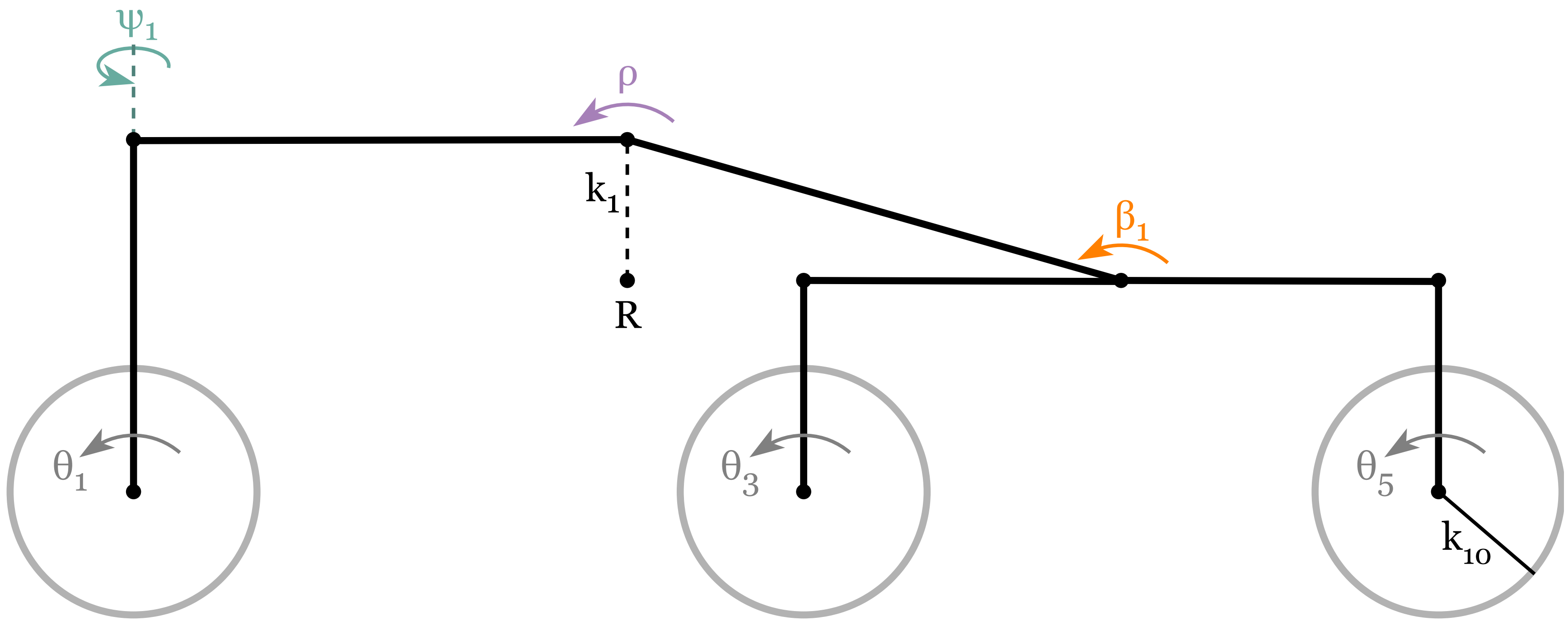
RoboMade Team



Coordinate frames for the left side of the rover

DH Table				
Frame	γ	d	a	α
D	0	k_1	0	-90
B$_1$	$k_9+\rho$	$k_3+\overline{k}_3$	k_6	0
B$_2$	$k_9-\rho$	$-k_3+\overline{k}_3$	k_6	0
S$_1$	ρ	k_3	k_4	90
S$_2$	$-\rho$	$-k_3$	k_4	90
S$_3$	β_1-k_9	0	k_7	90
S$_4$	β_1-k_9	0	k_7	90
S$_5$	β_1-k_9	0	$-k_7$	90
S$_6$	β_1-k_9	0	$-k_7$	90
A$_1$	ψ_1	$-k_5$	0	0
A$_2$	ψ_2	$-k_5$	0	0
A$_3$	0	$-k_8$	0	0
A$_4$	0	$-k_8$	0	0
A$_5$	0	$-k_8$	0	0
A$_6$	0	$-k_8$	0	0

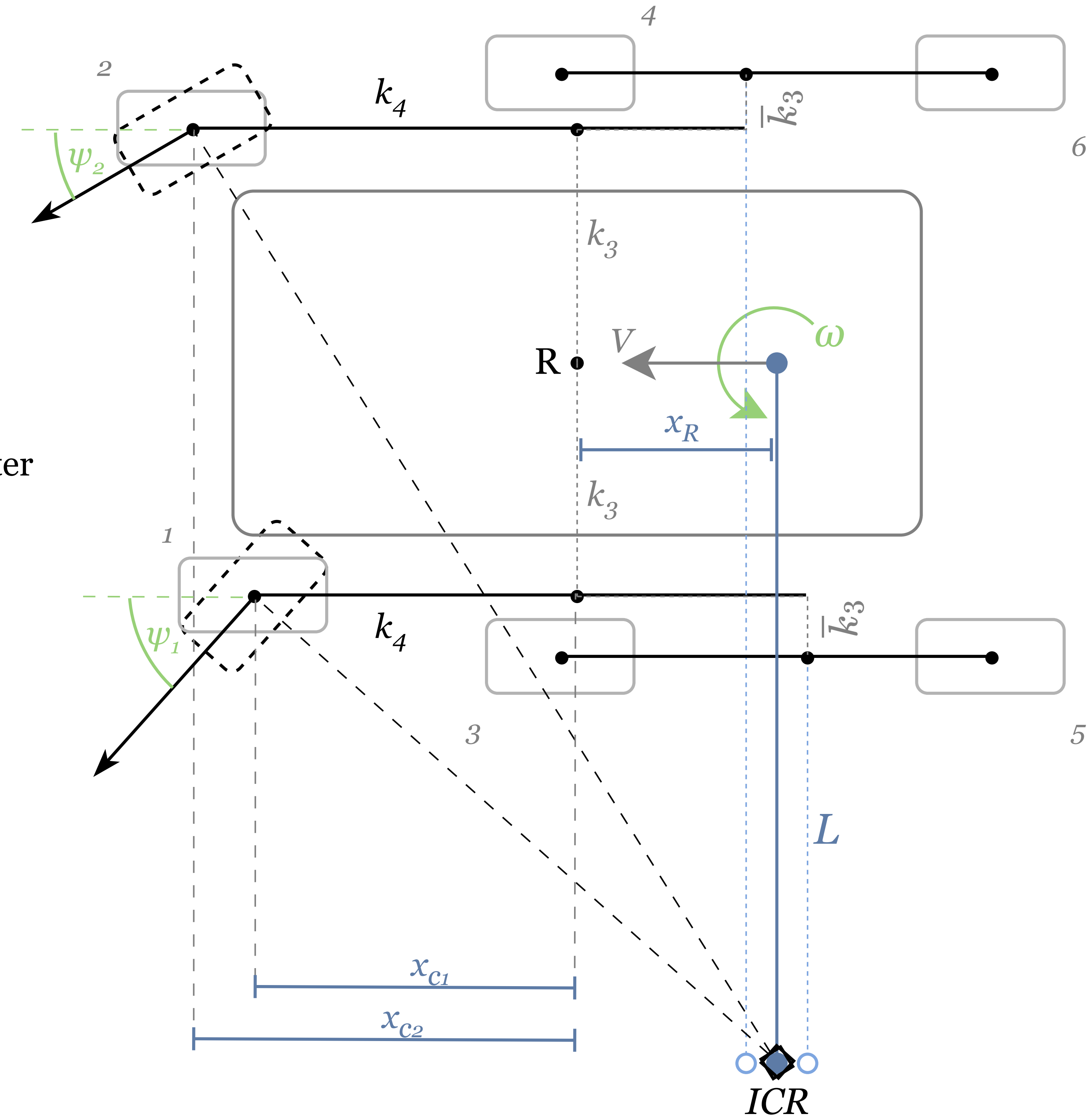
R = Rover reference frame
D = Differential frame
B$_i$ = Bogie frames (i = 1, 2)
S$_i$ = Steering frames (i = 1, ... , 6)
A$_i$ = Axle frames (i = 1, ... , 6)



Schematic diagram showing joint angles
and wheel rolling angles for the the rover's left side

$\boldsymbol{\psi}_i$ = Steering angles (i = 1, 2)
$\boldsymbol{\rho}$ = Left rocker angle
(*right rocker angle = -ρ)*
$\boldsymbol{\beta}_i$ = Bogie angle (i = 1, 2)
$\boldsymbol{\theta}_i$ = Wheel rolling angle (i = 1, … , 6)

Steering Angles and turning radius calculation based on input (V, ω)



$x_R =$ Distance from instataneous center of rotation (ICC) to rover reference frame $\boldsymbol{R}$ in x axis

$x_{ci} =$ Distance from wheel (i) center to rover reference frame $\boldsymbol{R}$ in x axis

$L =$ Turning radius

$$L = V/\omega$$

$$\psi_i = \tan^{-1}\left(\frac{x_{c_i} \pm x_R}{R \pm k_3}\right)$$

Wheel rolling velocities calculation based on input (V, ω)

$$v_1 = \omega \cdot \sqrt{(x_{c_2} + x_R)^2 + (L - k_3)^2}$$

$$v_2 = \omega \cdot \sqrt{(x_{c_2} + x_R)^2 + (L + k_3)^2}$$

$$v_3 = v_5 = \omega \cdot \left(L - k_3 - \overline{k}_3\right)$$

$$v_2 = v_4 = \omega \cdot \left(L + k_3 + \overline{k}_3\right)$$

$$\dot{\theta}_i = v_i / k_{10}$$