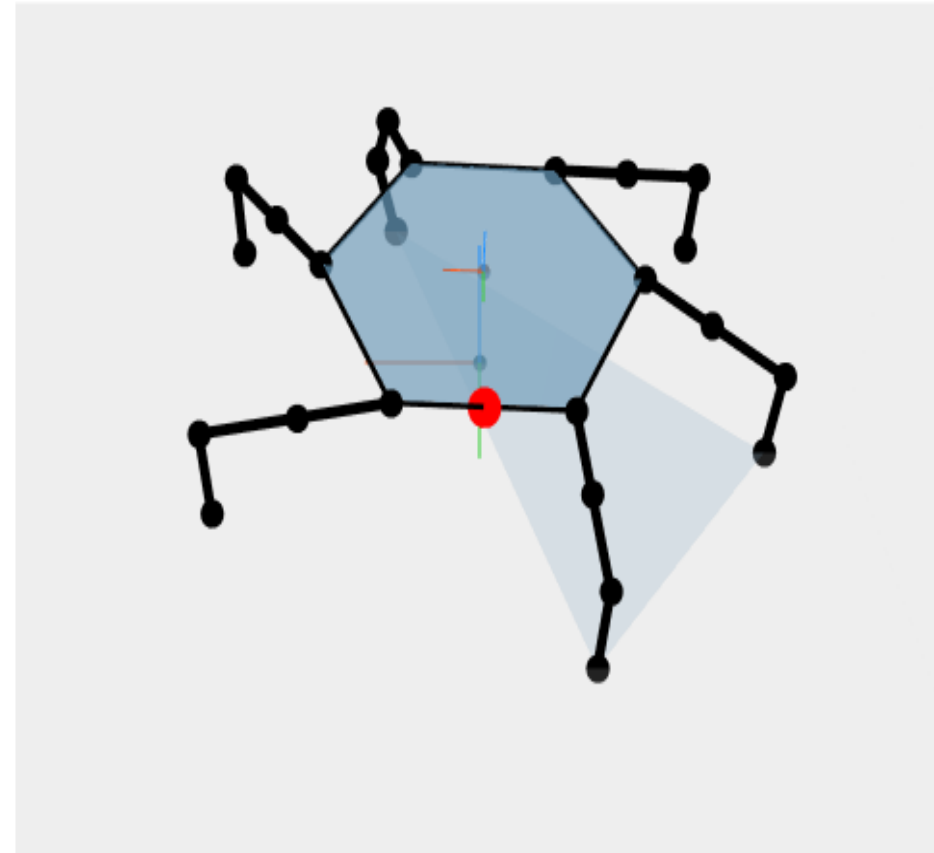


Hexapod Robot Simulator: Advancements in Kinematic Analysis

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Singh Alag



—●— robot-head
—●— robot-axis
—●— world-axis

Dimension Setting

Front

Middle

Side

coxa

Femur

Tibia

Reset Dimension

Reset Poses

Reset 3D View

Section 1

Introduction to Robotics Simulation

Importance of Simulation in Robotics

01

Simulation Significance

Robotics simulation plays a pivotal role in testing and validating robot behaviors and functionalities before physical implementation, saving time and resources.

02

Applications

There are diverse applications of robotics simulation in research, development, and real-world scenarios, showcasing its impact on technological advancements.

03

Visualization and Analysis

Simulation aids in visualizing complex robot movements and analyzing performance metrics, fostering innovation and problem-solving.

Section 2

Challenges and Opportunities in Hexapod Simulation

Unique Challenges of Stationary Hexapod Robots

01

Stability and
Maneuverability

02

Complex Leg
Mechanics

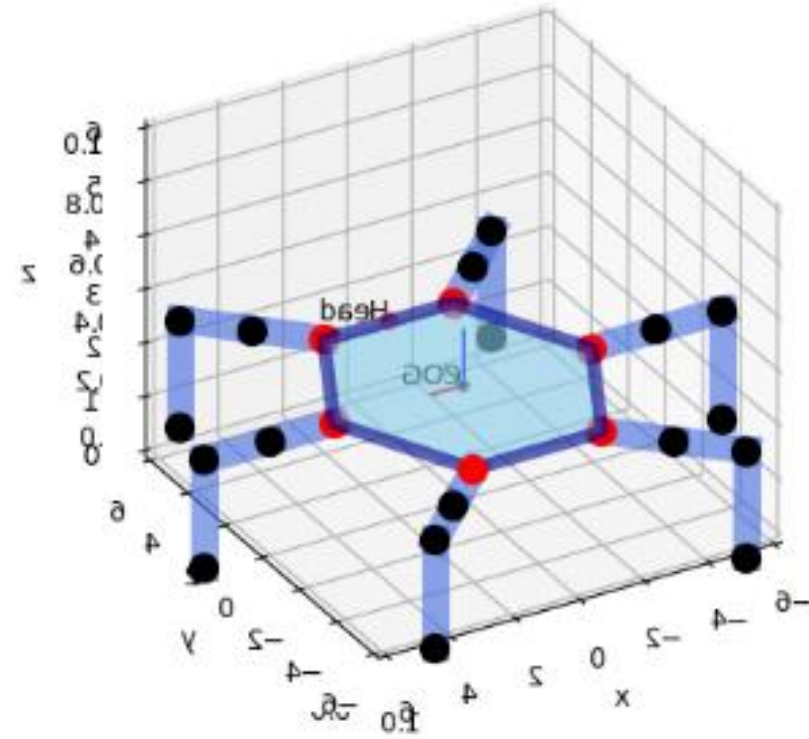
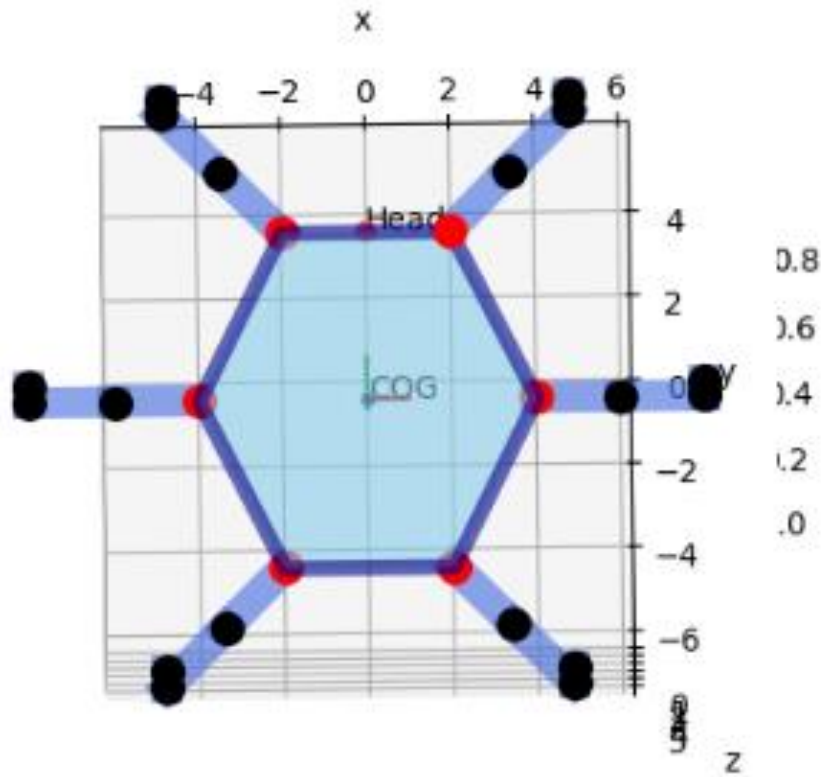
03

Visualization

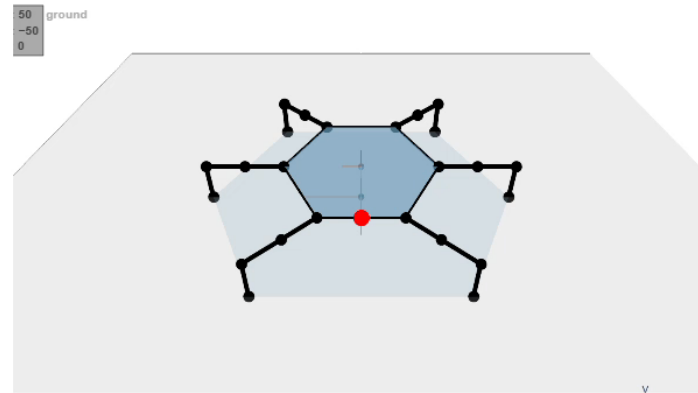
Section 3

Kinematic Modeling and Visualization

Simulator Overview



Leg Pattern Manipulation



Dimension Setting

robot-head
robot-axis
world-axis

Front

Middle

Side

coxa

Femur

Tibia

Reset Dimension

Reset Poses

Reset 3D View

Inverse Kinematics	Leg Pattern	Forward Kinematics	Walking Gaits	Kinematic Phase Diagram
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Adjust the angles of the leg joints to define the leg pattern.

Input Parameters:

- Coxa Angle (α): Angle of the coxa joint, which controls the lateral movement of the leg.
- Femur Angle (β): Angle of the femur joint, which controls the forward and backward movement of the leg.
- Tibia Angle (γ): Angle of the tibia joint, which controls the up and down movement of the leg.

Each leg shares the same pose defined by these angles.

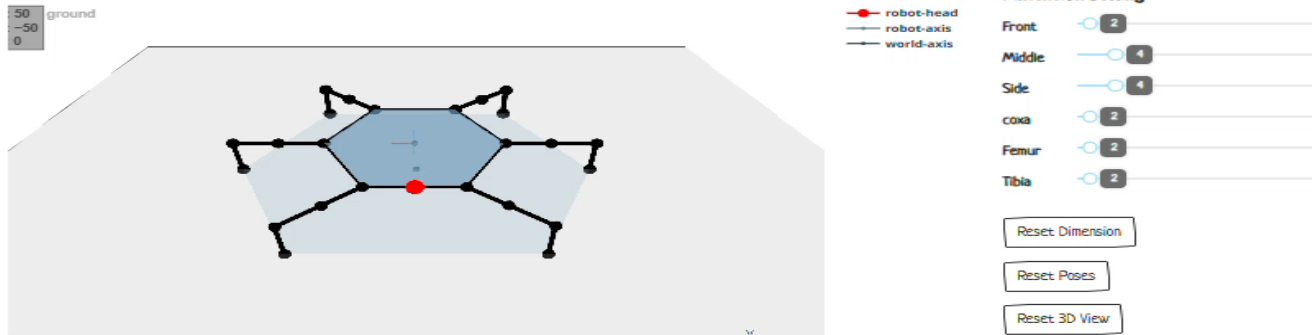
Adjust the sliders for each joint angle and observe the leg pattern visualization.

α (coxa)

β (femur)

γ (tibia)

Understanding Inverse Kinematics



Dimension Setting

Front: 2
Middle: 4
Side: 4
coxa: 2
Femur: 2
Tibia: 2

Reset Dimension
Reset Poses
Reset 3D View

Inverse Kinematics Leg Pattern Forward Kinematics Walking Gaits Kinematic Phase Diagram

TX: 0.04
RX: 0
Hip Stance: 0
TY: 0
RY: 0
Leg Stance: 0
TZ: 0
RZ: 0

Inverse Kinematics Output:

Leg	Coxa	Femur	Tibia
MiddleRight	-90.00	-0.05	-60.64
FrontRight	-44.18	-0.02	-78.29
FrontLeft	45.80	-0.02	-75.17
MiddleLeft	90.00	-0.05	-59.32
RearLeft	134.20	-0.02	-45.30
RearRight	-135.82	-0.02	-45.07

Explanation of Input Values:

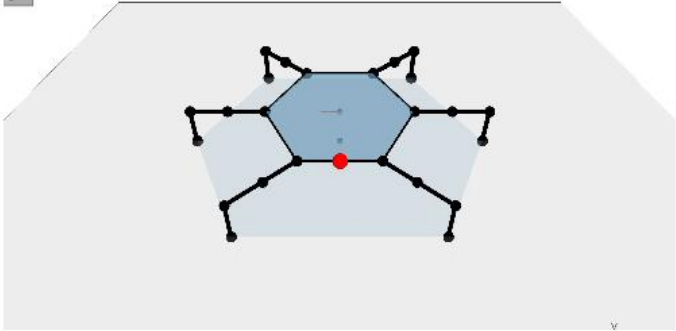
The input values represent the rotation angles and translation distances for the robot legs.

- IK-RX: Rotation angle around the X-axis (roll) in degrees.
- IK-RY: Rotation angle around the Y-axis (pitch) in degrees.
- IK-RZ: Rotation angle around the Z-axis (yaw) in degrees.
- IK-TX: Translation distance along the X-axis in meters.
- IK-TY: Translation distance along the Y-axis in meters.
- IK-TZ: Translation distance along the Z-axis in meters.

Forward Kinematics

50
-50
0

ground



robot-head

robot-axis

world-axis

Dimension Setting

Front 2

Middle 4

Side 4

coxa 2

Femur 2

Tibia 2

Reset Dimension

Reset Poses

Reset 3D View

Inverse Kinematics

Leg Pattern

Forward Kinematics

Walking Gaits

Kinematic Phase Diagram

MiddleRight

α

β

γ

FrontRight

α

β

γ

FrontLeft

α

β

γ

MiddleLeft

α

β

γ

RearLeft

α

β

γ

RearRight

α

β

γ

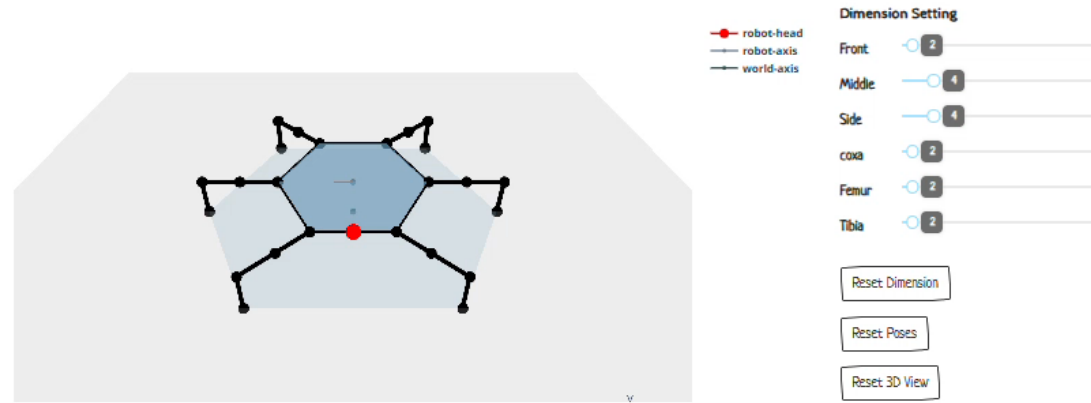
Explanation of Input Values:

The input values represent the angles of rotation for each joint of the robot legs.

- alpha: Rotation angle of the coxa joint in degrees.
- beta: Rotation angle of the femur joint in degrees.
- gamma: Rotation angle of the tibia joint in degrees.

Adjust these values to specify the desired joint angles for the robot legs.

Kinematic Phase Diagram



Inverse Kinematics	Leg Pattern	Forward Kinematics	Walking Gaits	Kinematic Phase Diagram
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This Kinematic Phase diagram currently handles only forward symmetric wave gaits.

xscale affects the number of blocks you want to use to represent parts where the phase (support and transfer) of all the blocks remain the same. It has to be an integer. Typically 1 or 2.

Input Parameters:

- Duty Factor: The ratio of time a leg spends in the support phase compared to the total cycle time.
- Number of Legs: The total number of legs in the robot. Can be a number other than 6
- XScale: A factor that controls the number of blocks used to represent the phase.

Adjust these parameters to visualize the kinematic phase diagram for different configurations of the robot.

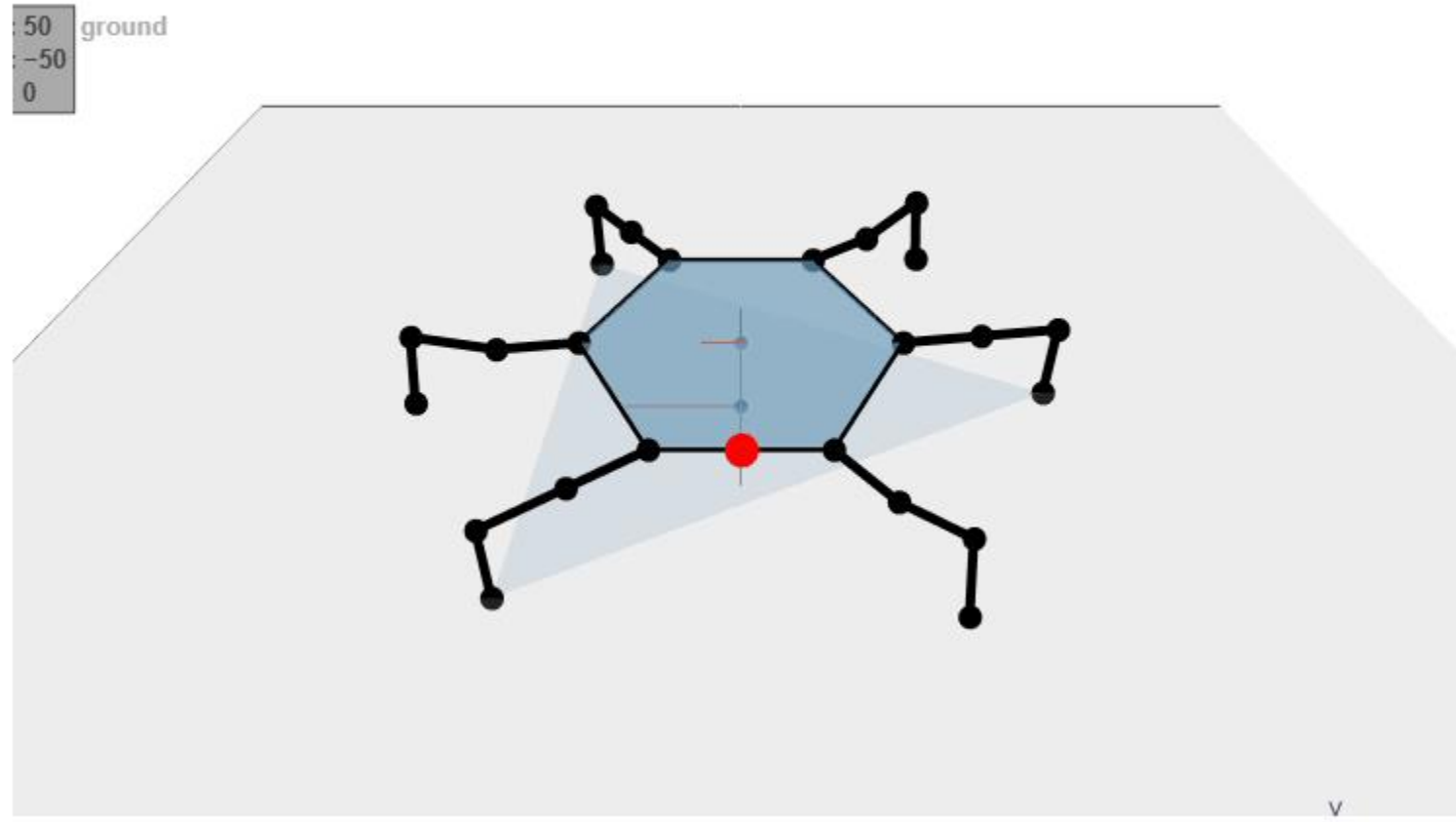
After providing the input values, click 'Update Diagram' to generate the kinematic phase diagram.

XSCALE affects the number of blocks you want to use to represent parts where the phase (support and transfer) of all the blocks remain the same. It has to be an integer. Typically 1 or 2

Duty Factor	<input type="text"/>	Number of Legs	<input type="text"/>	XScale	<input type="text"/>	Update Diagram
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Walking Gait



Limitations & Next Steps

01

Additional Constraints
& Environmental
Simulation

02

Kinematic phase
diagrams for different
Gaits

03

Simulation for different
gaits.

Thank You

The background features a dark blue gradient with several translucent, flowing ribbons in shades of blue and purple. These ribbons create a sense of movement and depth. Scattered throughout the background are numerous small, white, star-like specks, giving the impression of a cosmic or digital space.