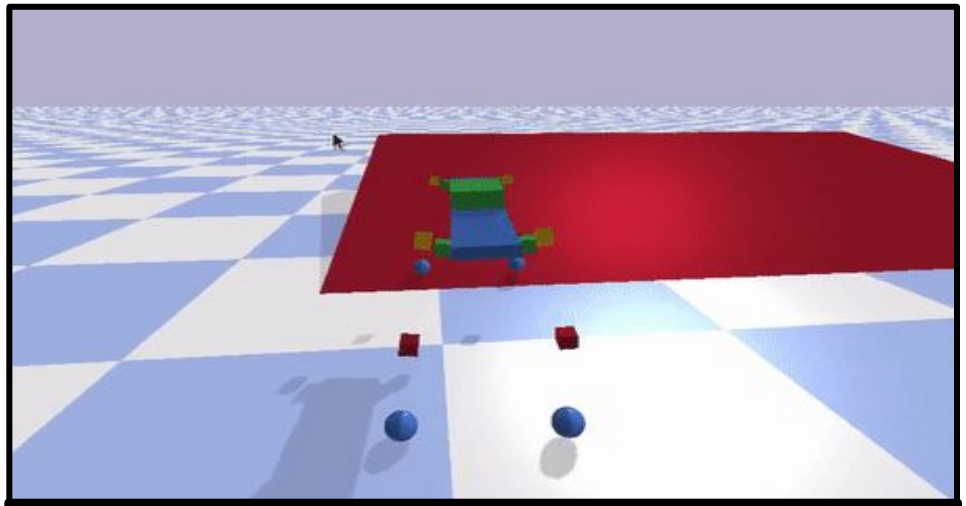
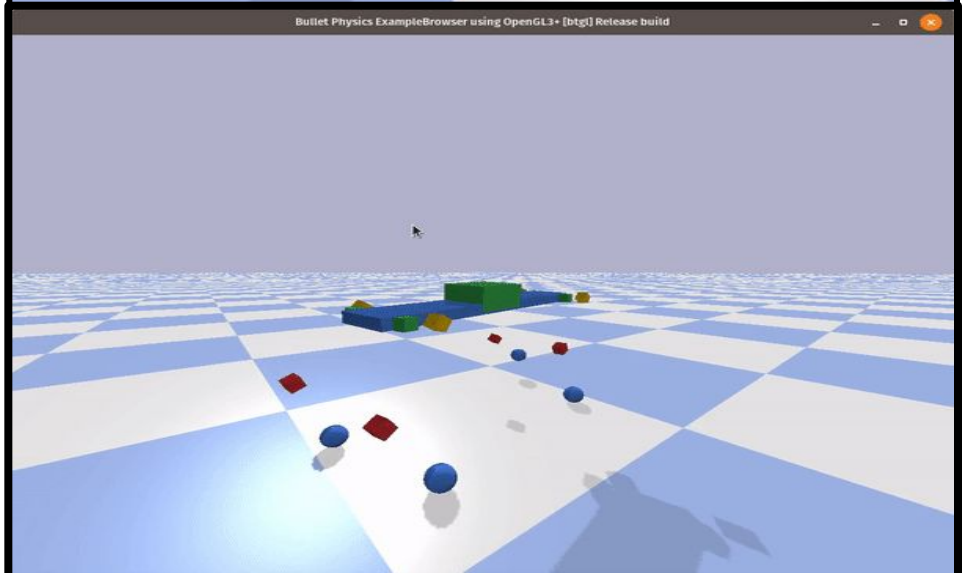




Modelling a Package Delivering Robot Dog in Difficult Terrains

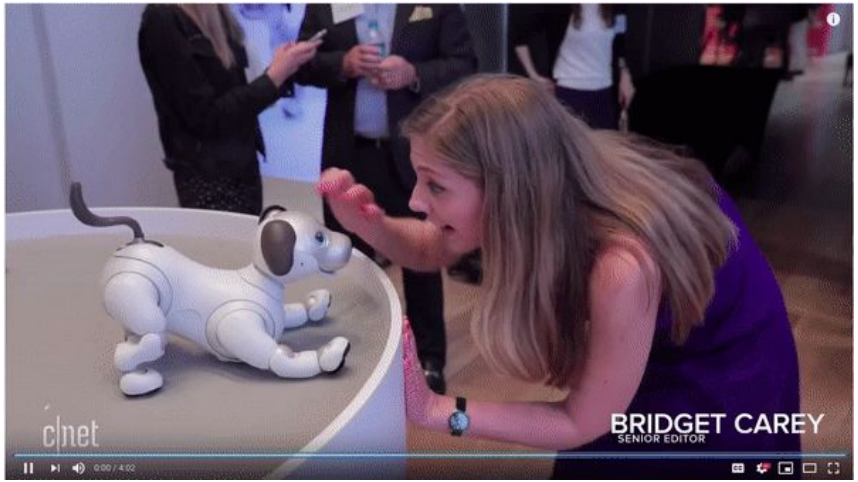
Shivam Akhauri 116352031

Motivation

Interaction with robot pets releases cuddle hormone

Personal defense and care

Package Delivery in harsh terrains

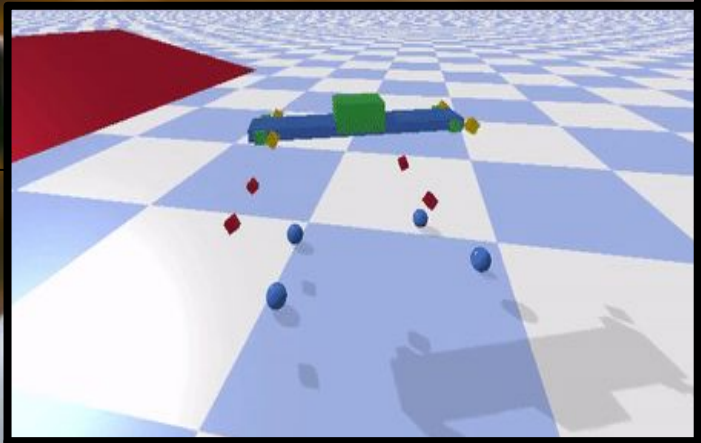


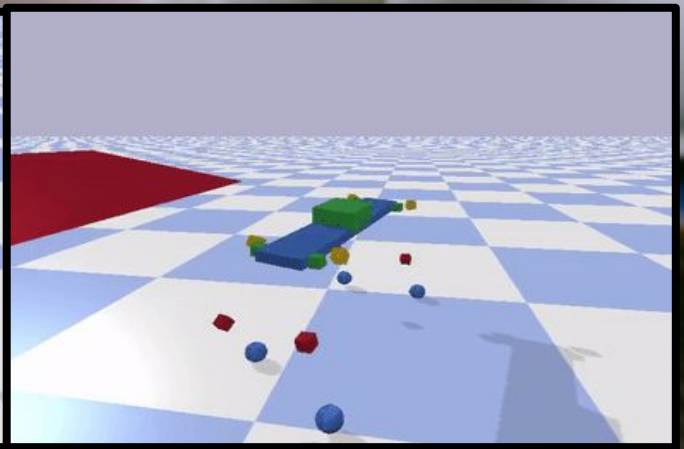
Sources: https://www.youtube.com/watch?v=M8YjvHYbZ0w

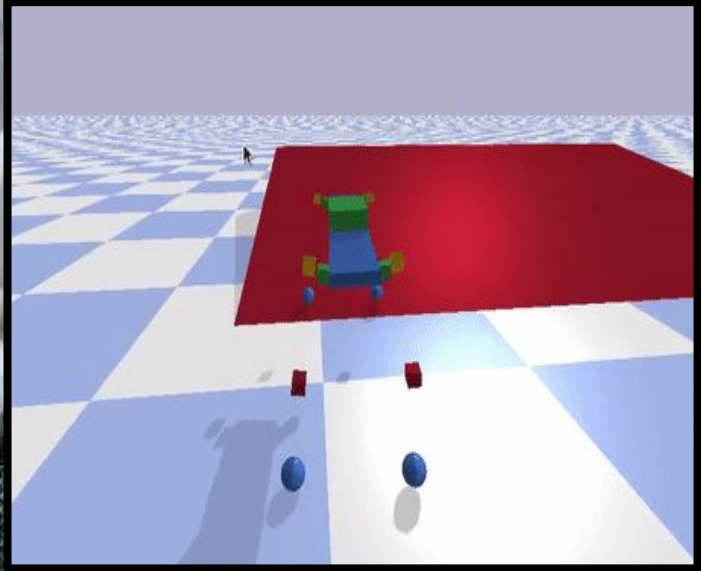
Sources:https://www.youtube.com/watch?v=oGo0TwNXXuo

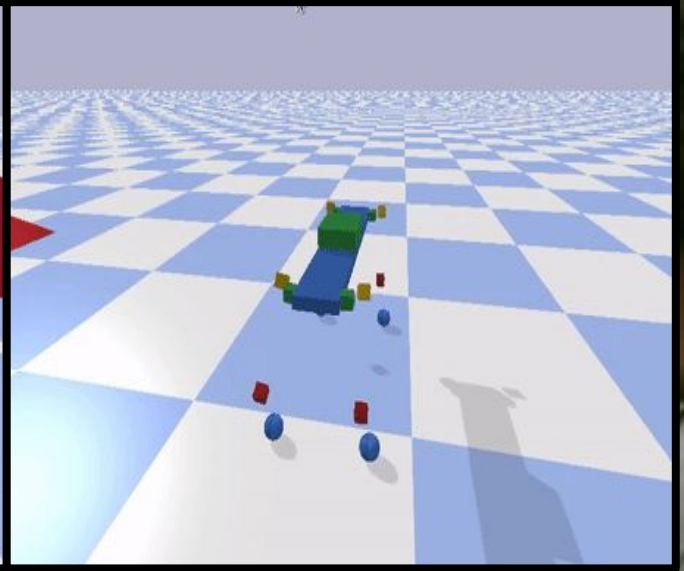
Objectives Achieved

1. Model Left Turn, right turn , backward movement
2. Model a robot carry weight
3. Model the robot climb a hill
4. Model a Walking Gait
5. Model Amble Gait

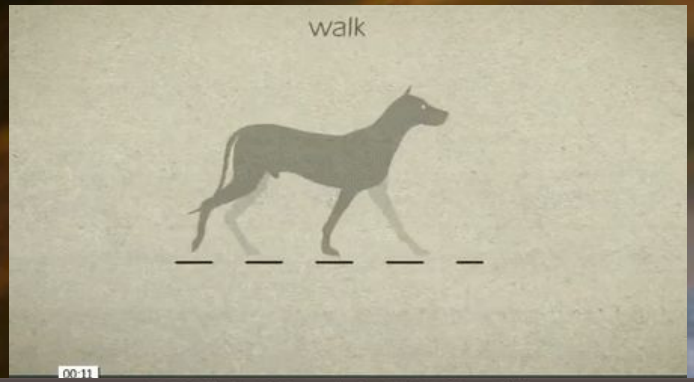


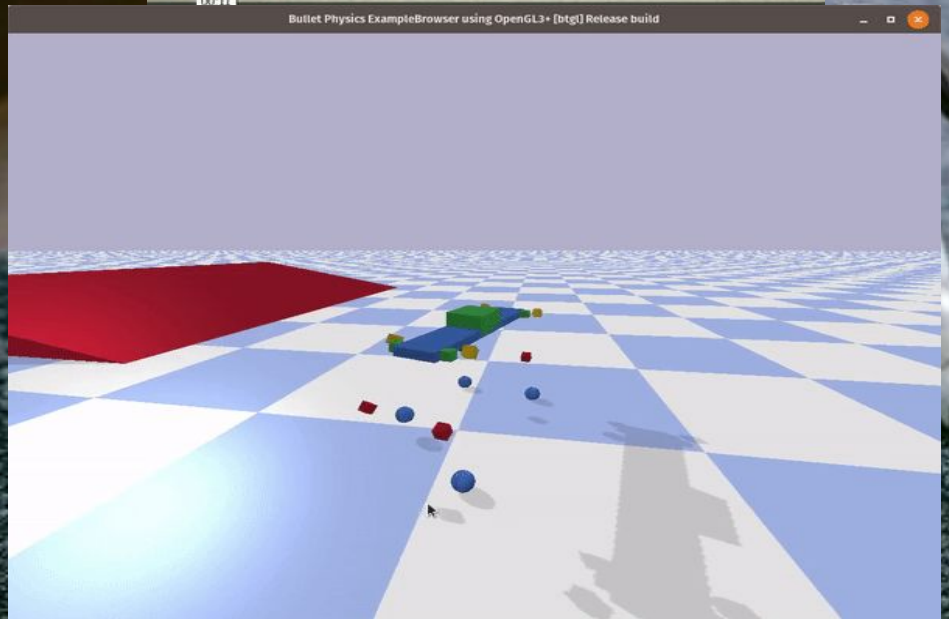


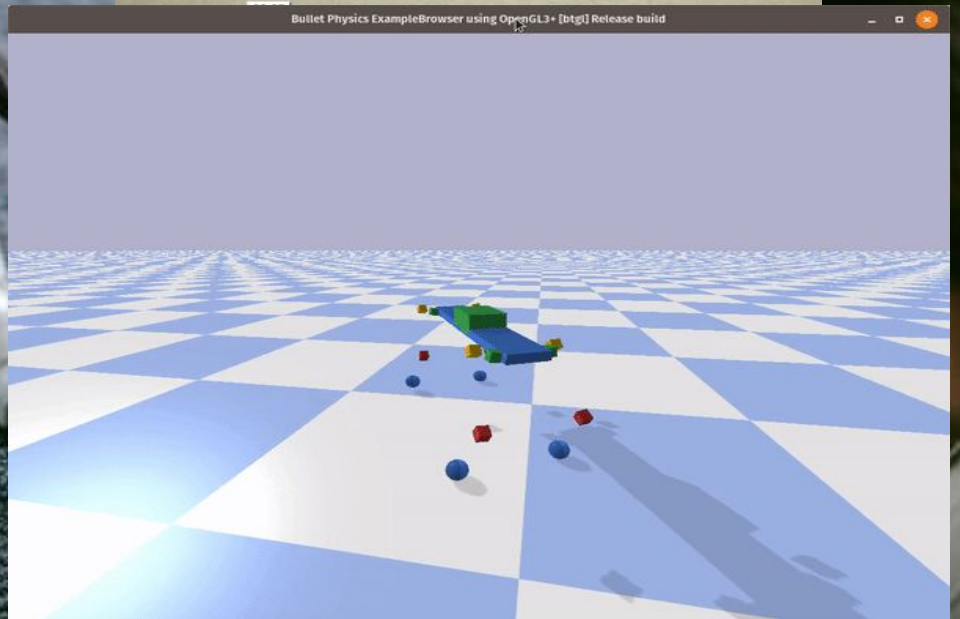




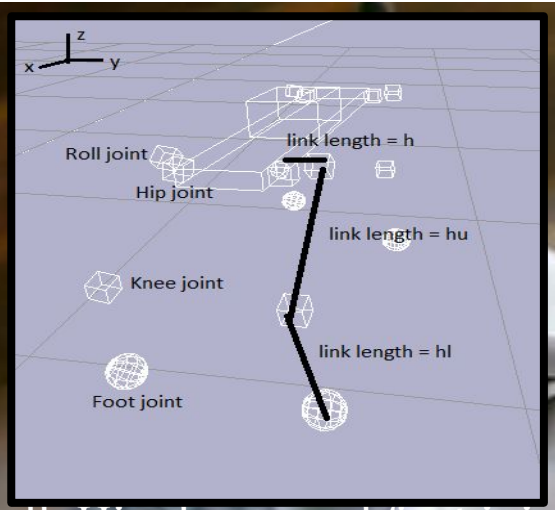
Objectives Achieved



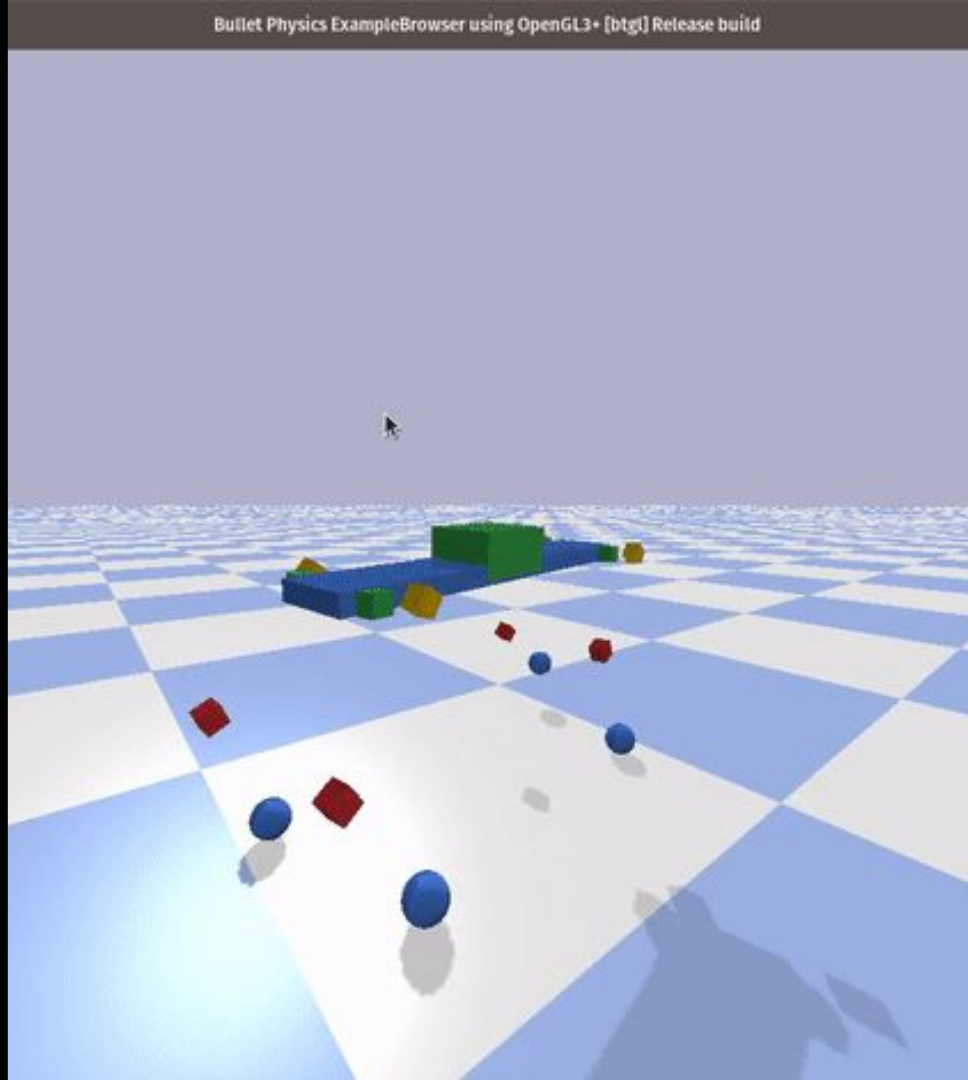




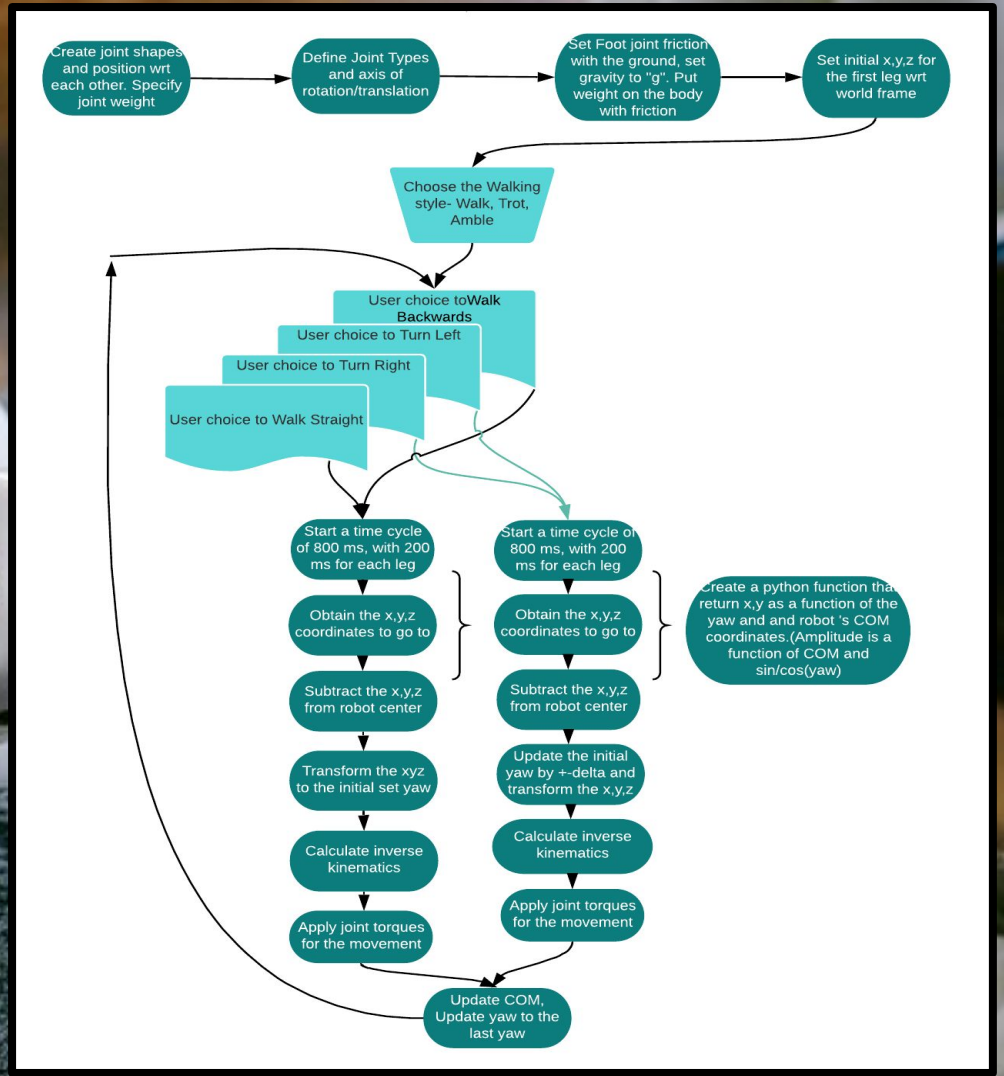
Robot Description



1. Roll, Hip, knee and foot joints.
2. 12 degrees of freedom (3 in each leg)
3. Robot is massless
4. Small cubes are rotational, sphere is the foot joint. Frictional force acts on it.
5. Carries a weight

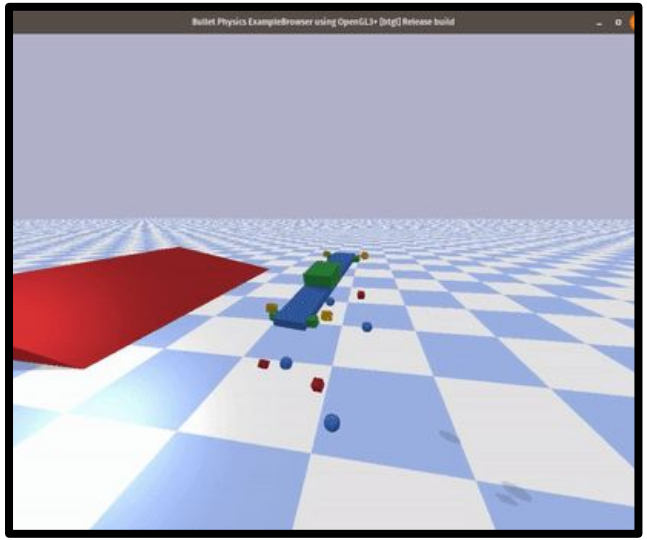


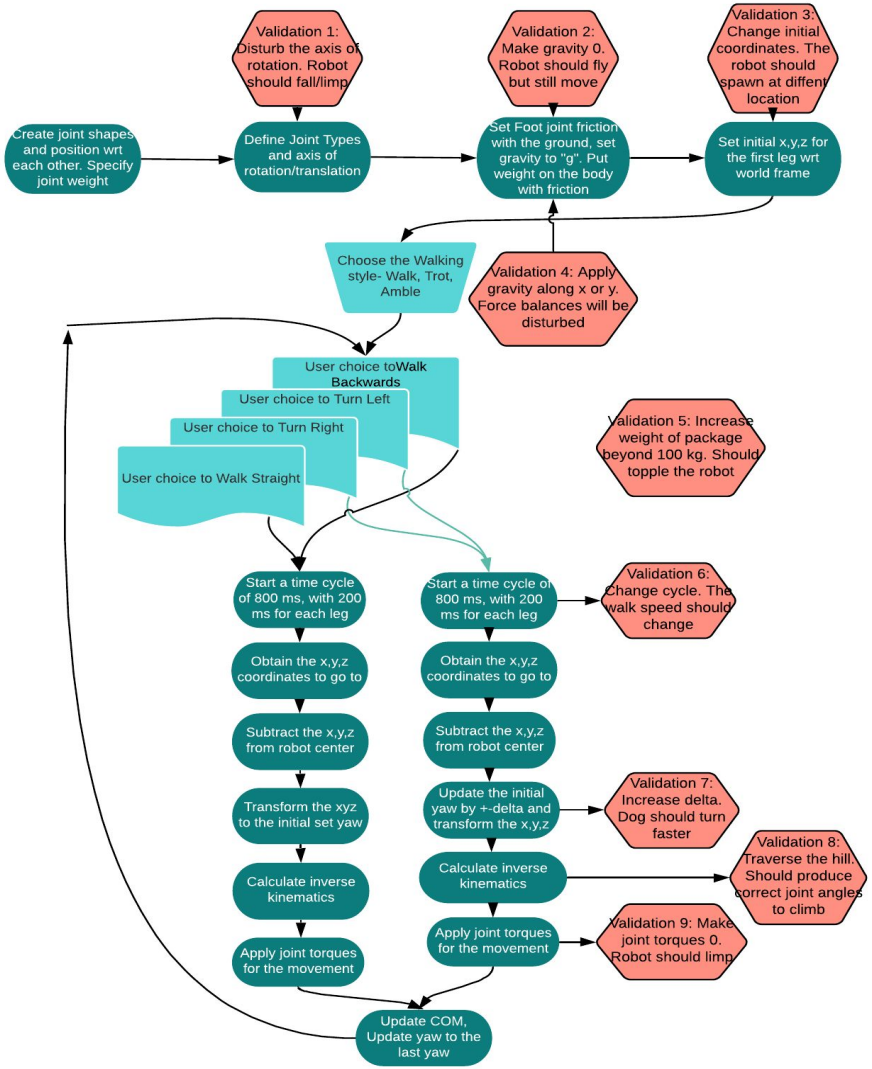
Block Diagram

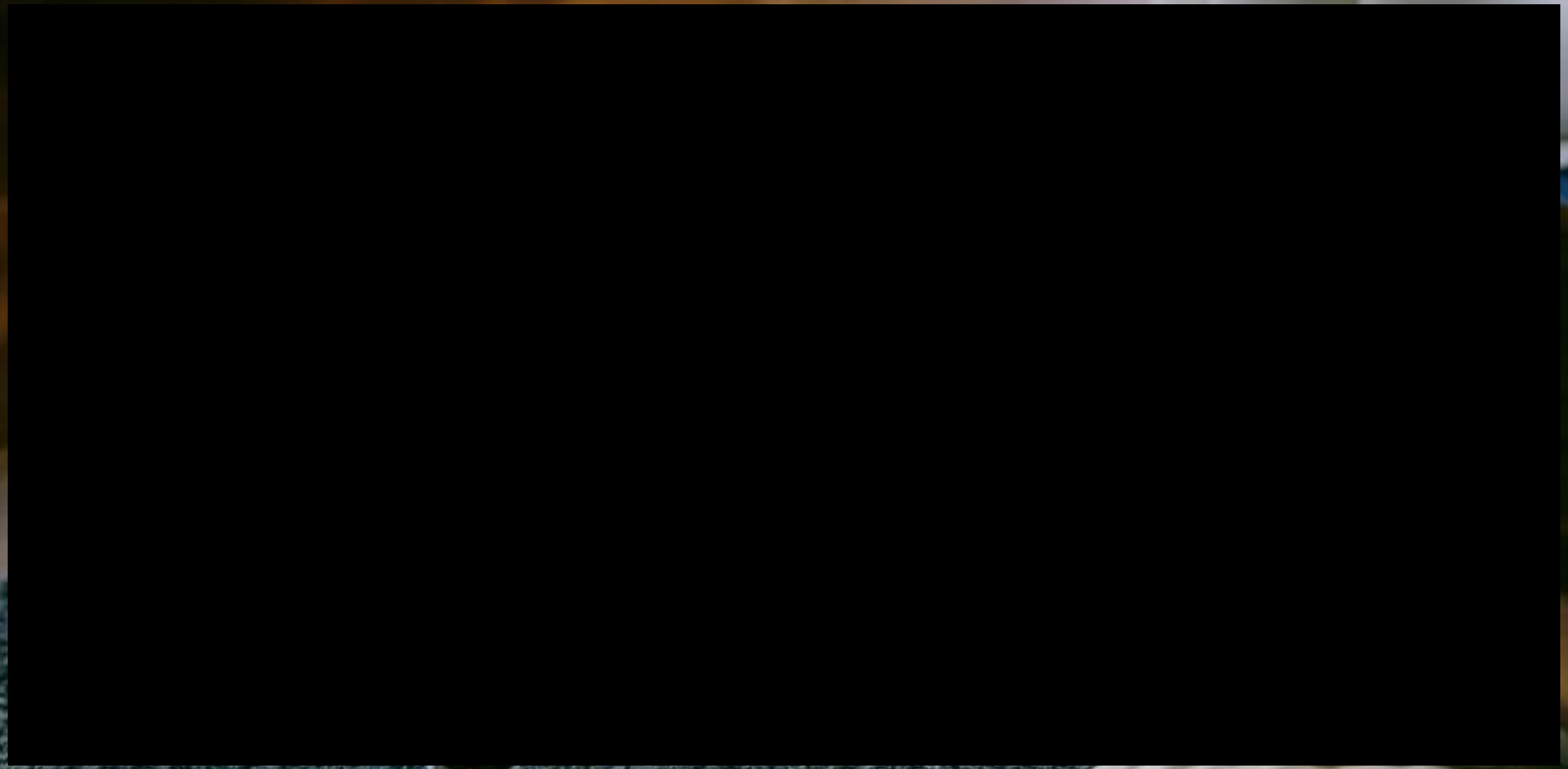


Validation Plan

The blocks in red are the validation plans to test each stage of the architecture







Validation test cases results

Modelling

Kinematics of the leg joints

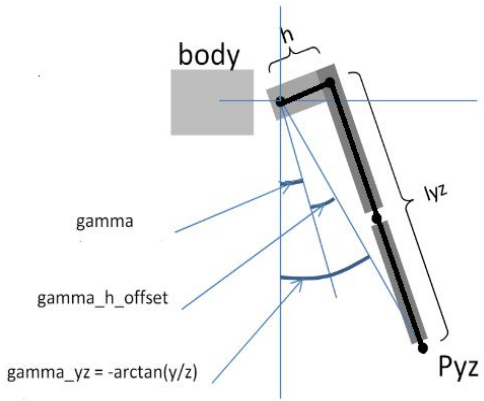
$R_{c,FJ}$ = [[cos(Yaw),-sin(Yaw),0];
[sin(Yaw),cos(Yaw),0];
[0,0,1]]
$D_{c,FJ}$ = [L/2,W/2,hu+hl]

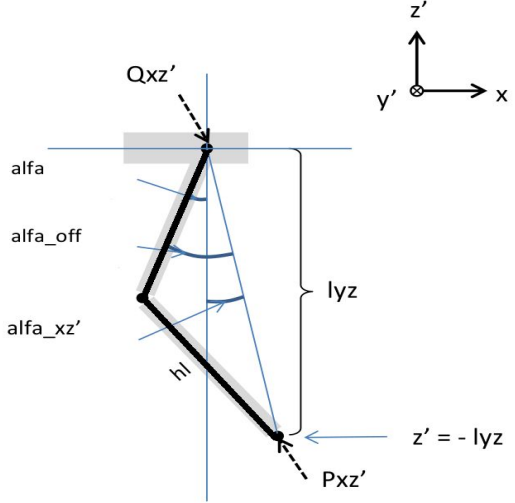
Inverse Kinematics of the leg joints:

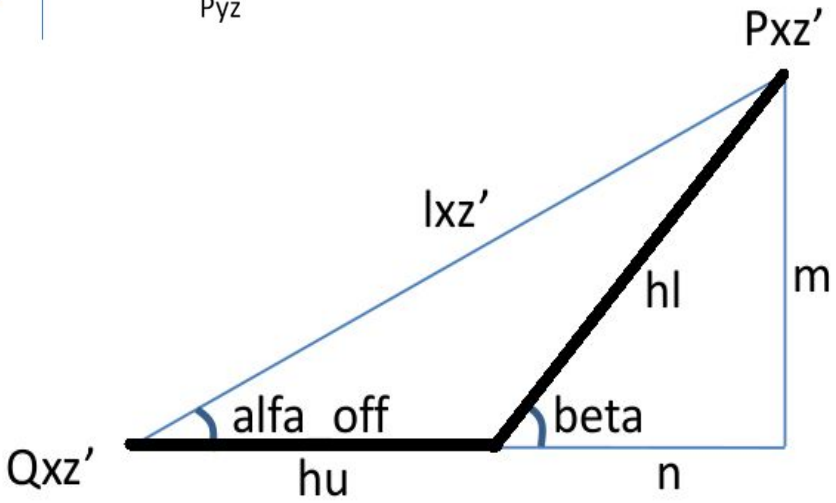
alpha= $alpha_{off}$ - $alpha^{xz'}$
Beta = -arccos(n/hl)
gamma = $gamma_{yz}$ + $gamma_{Offset}$

Dynamics:

F <= u Mg, where u= 1 and F =1000N
Then for 1000N force, the maximum weight of the package is 100Kg.

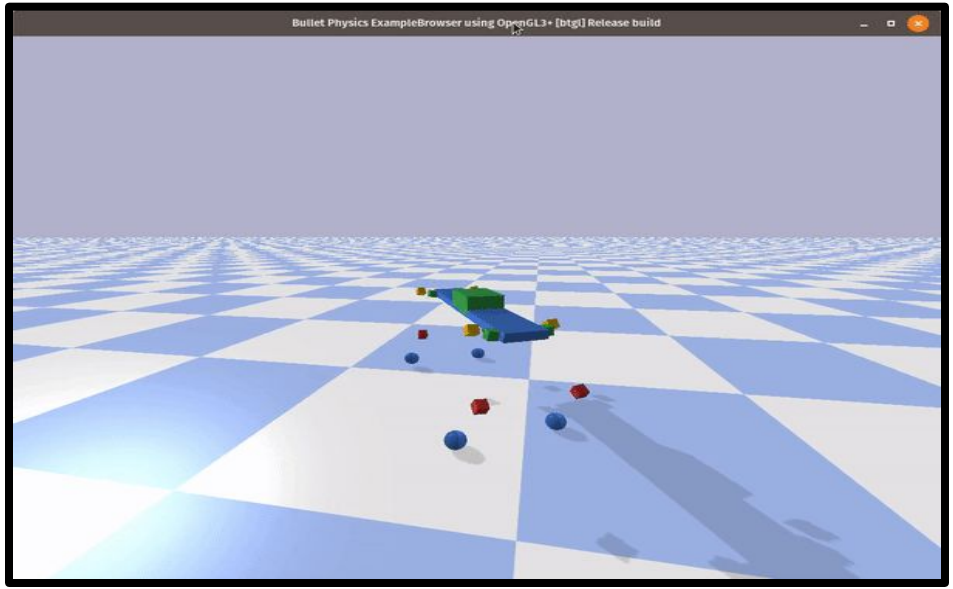


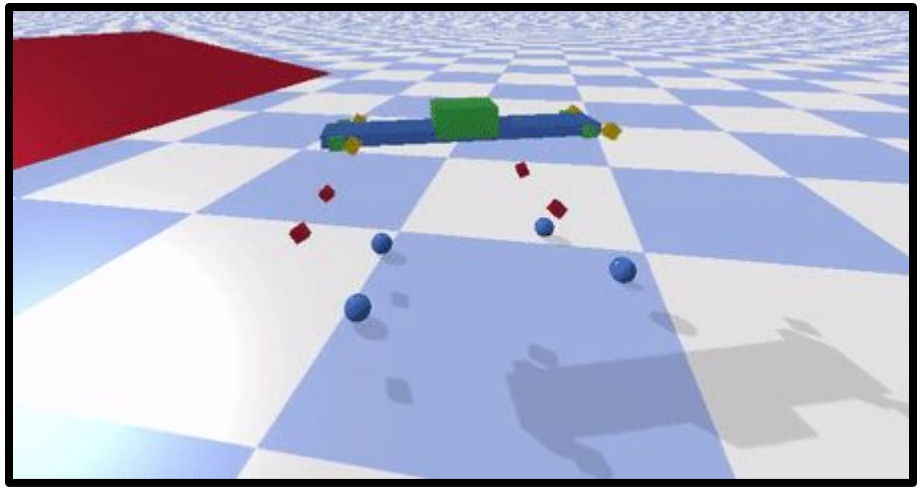




Assumptions:

- The Acceleration due to gravity is g 9.8 m per sec sq.
- The robot is controlled by keyboard. The arrow keys gives direction to the robot. The robot doesn't have it's own vision.





- The Robot is massless but carries the weight of the package. The COM is adjusted in the walk cycle.
- The package is fixed on the back of the robot dog with static friction. The maximum load allowed is 100 Kg,
- Tripod gait. Three legs always on the ground.

Conclusions

A massless robot dog can be implemented by receiving x, y and z coordinates of the foot joint from the simulator and derive joint angles from those coordinates using inverse kinematics

The robot can be maneuvered by the controls from the user using the Up down left and right arrow keys

The rhythmic movement of the robot dog can be modelled using basic sine/cosine function. These cyclic coordinates can be passed to inverse kinematics functions and power the robot dog joints to move in a rhythmic pattern.

The motion of the robot dog is made cyclic by taking a time cycle of 800 ms, where each leg takes 200 ms to move and come back to the ground.

The COM of the robot is shifted back and forth in each 800 ms cycle.

The COM is shifted in opposite direction of the leg to be moved, to ensure COM remains on the other 3 legs.

When the moving legs go down again, the COM return to the robot center.