Simulation

Mobile Robotics

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Today

- Simulation
- Second set of slides for motion planning

Simulation

- Find the right level of abstraction
- Answer the question: what do you care about?

Simulation

- Find the right level of abstraction
- Answer the question: what do you care about?
  - Do you care about the electromechanical properties?
  - Do you care about inertia?
  - Do you care about battery levels or capacity?
  - Do you care about noise? Or wheel slippage?

Analytical Model Simulation

Example: A Two-Dimensional WMR

$$x_t = x_0 + \omega r t$$

Analytical Model Simulation

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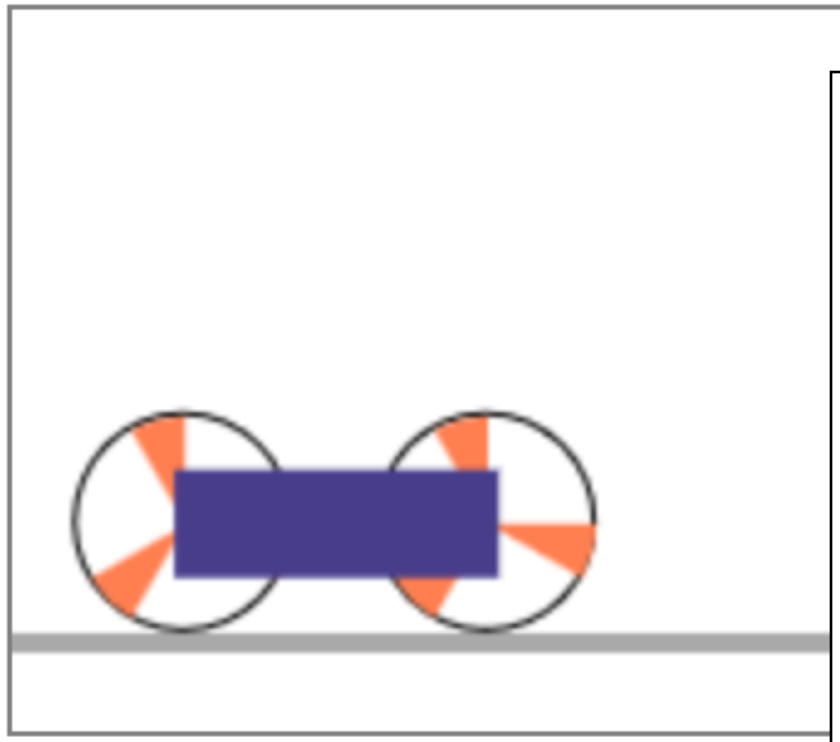
$$x_t = x_0 + \omega r t$$

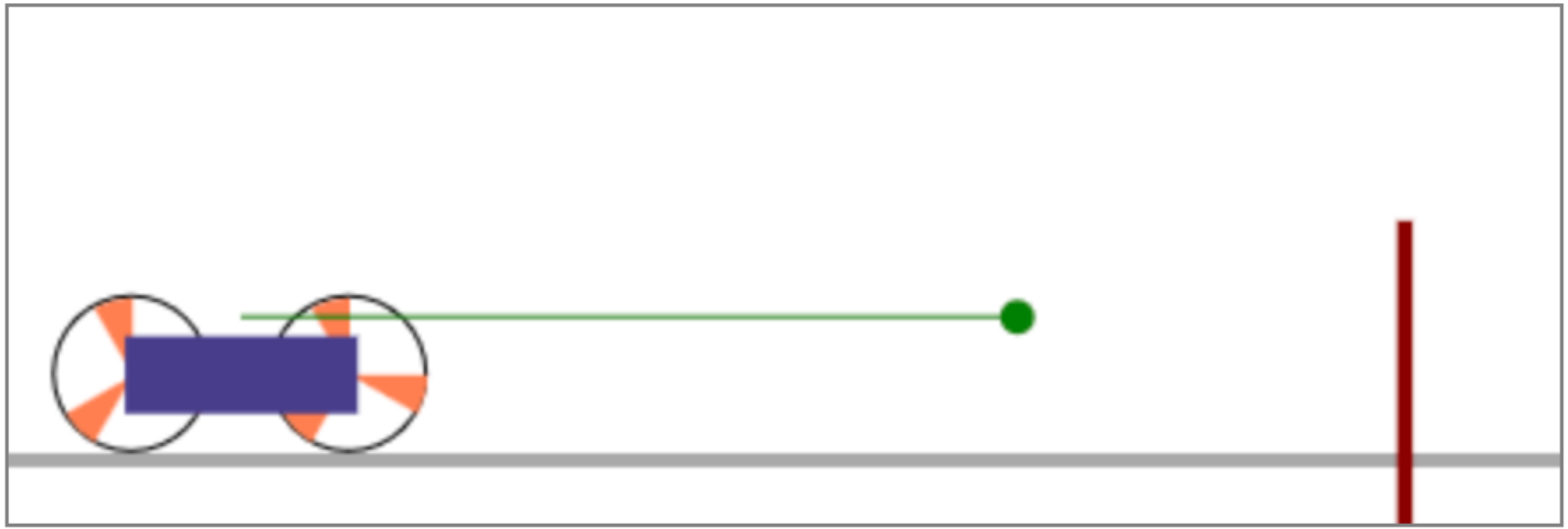


```
let initialPosition = 0;
let chassisPosition;

let angularVelocity = 1;
let wheelRadius = 1;

function simulate( time ) {

    // x = x0 + ω r t
    v = angularVelocity * wheelRadius
    chassisPosition = initialPosition + v * time;

}
```

Analytical Model Simulation

What if We Add a Wall?

$$x_t = x_0 + \omega r t$$

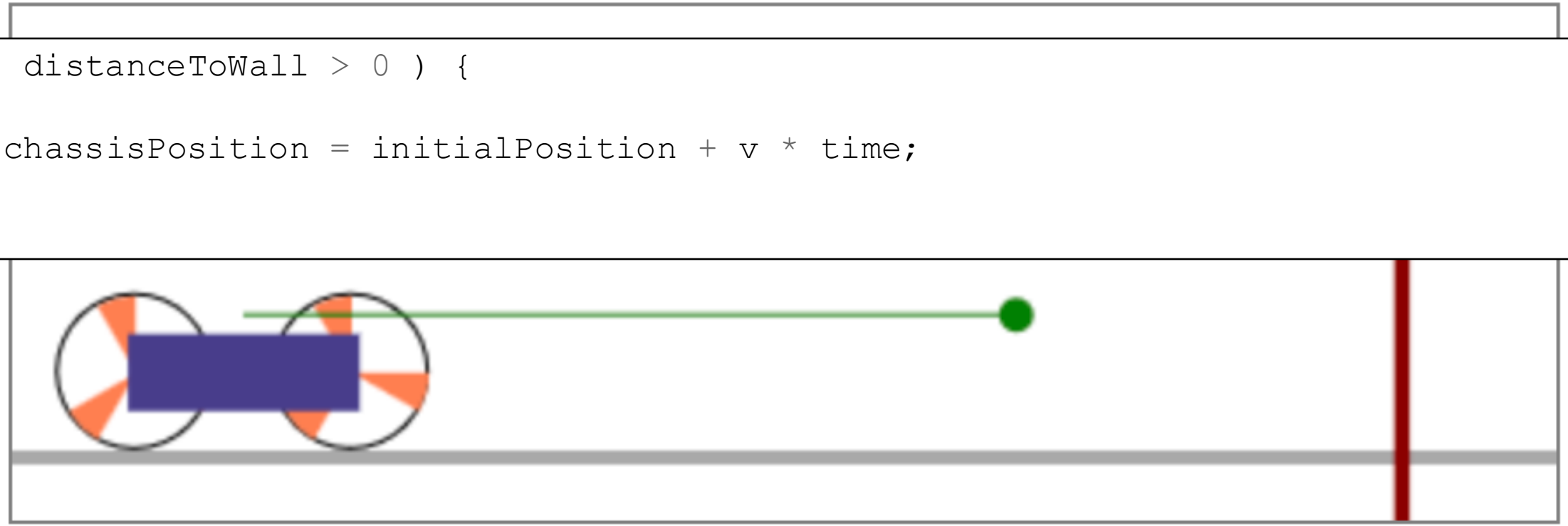


Analytical Model Simulation

What if We Add a Wall?

$$x_t = x_0 + \omega r t$$

```
if ( distanceToWall > 0 ) {

    chassisPosition = initialPosition + v * time;

}
```



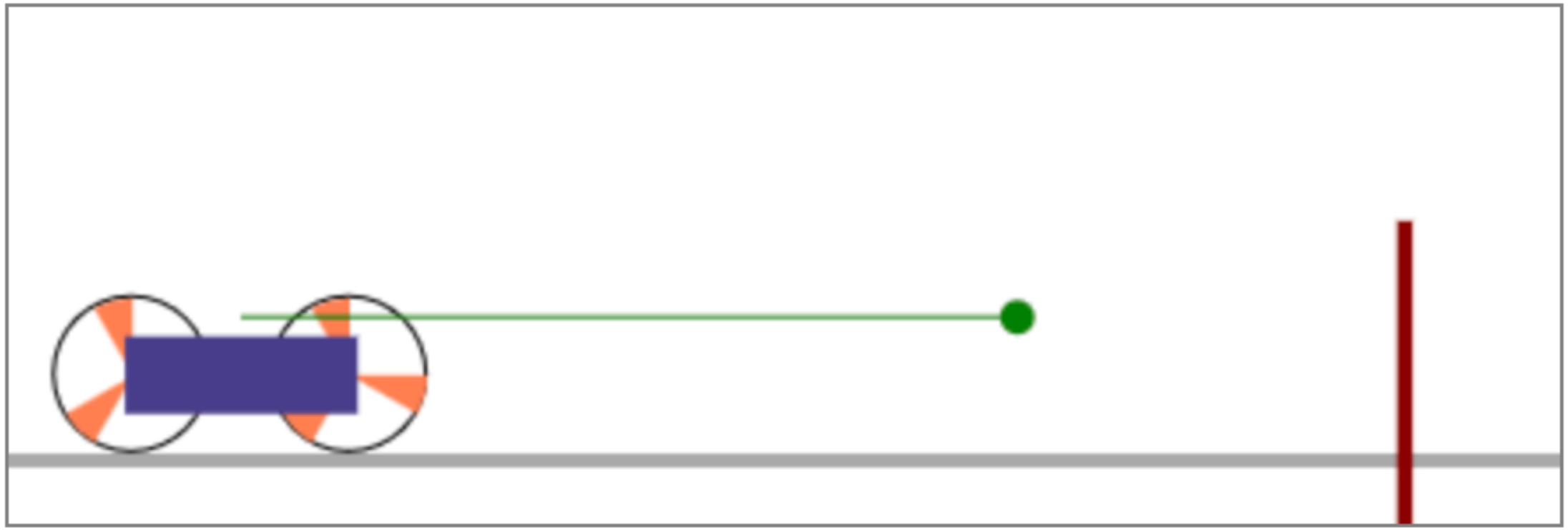
Analytical Model Simulation

What if We Want Dynamic Control?

$$x_t = x_0 + \omega r t$$

Where,

$$\omega = \text{constrain}(Kd + b, -\Omega, \Omega)$$

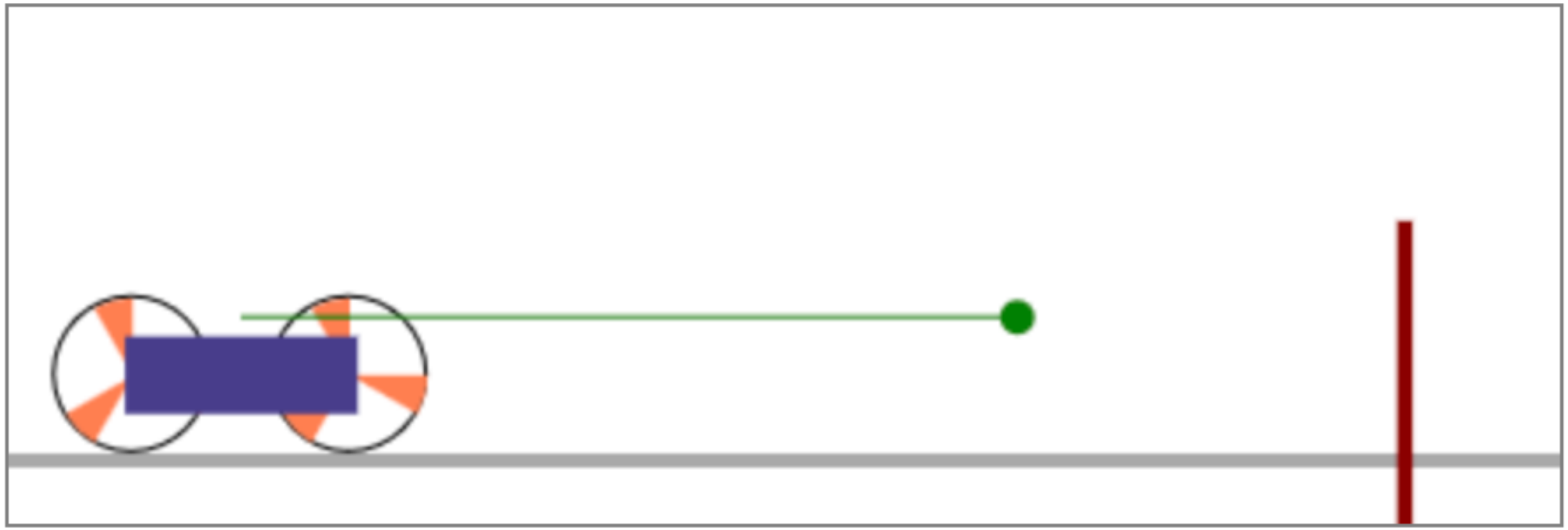


Analytical Model Simulation

Numerical Simulation

$$x_t = x_0 + \omega r t \qquad \text{(1) Analytical}$$

$$x_t = x_{t-1} + \omega r \Delta t \qquad \text{(2) Numerical}$$



Dynamic Control

Numerical Simulation Code

$$x_t = x_{t-1} + \omega r \Delta t$$

```
let initialPosition = 0;
let chassisPosition = initialPosition;

let angularVelocity = 1;
let wheelRadius = 1;
```

```
function simulate( duration )  {

        let time = 0;
        const timeStep = 0.01;
        let v = angularVelocity * wheelRadius

        while ( time < duration ) {

                chassisPosition += v * timeStep;
                time += ;

        }

}
```

Demo