

CASE simulink(part1)

To make our car runs more faster and in higher efficiency, we simulate our in the software "MATLAB2009"

In the circuit, we make the electrical part on the left, the mechanical part one the right. Between is the "bridge"-- DC motor.

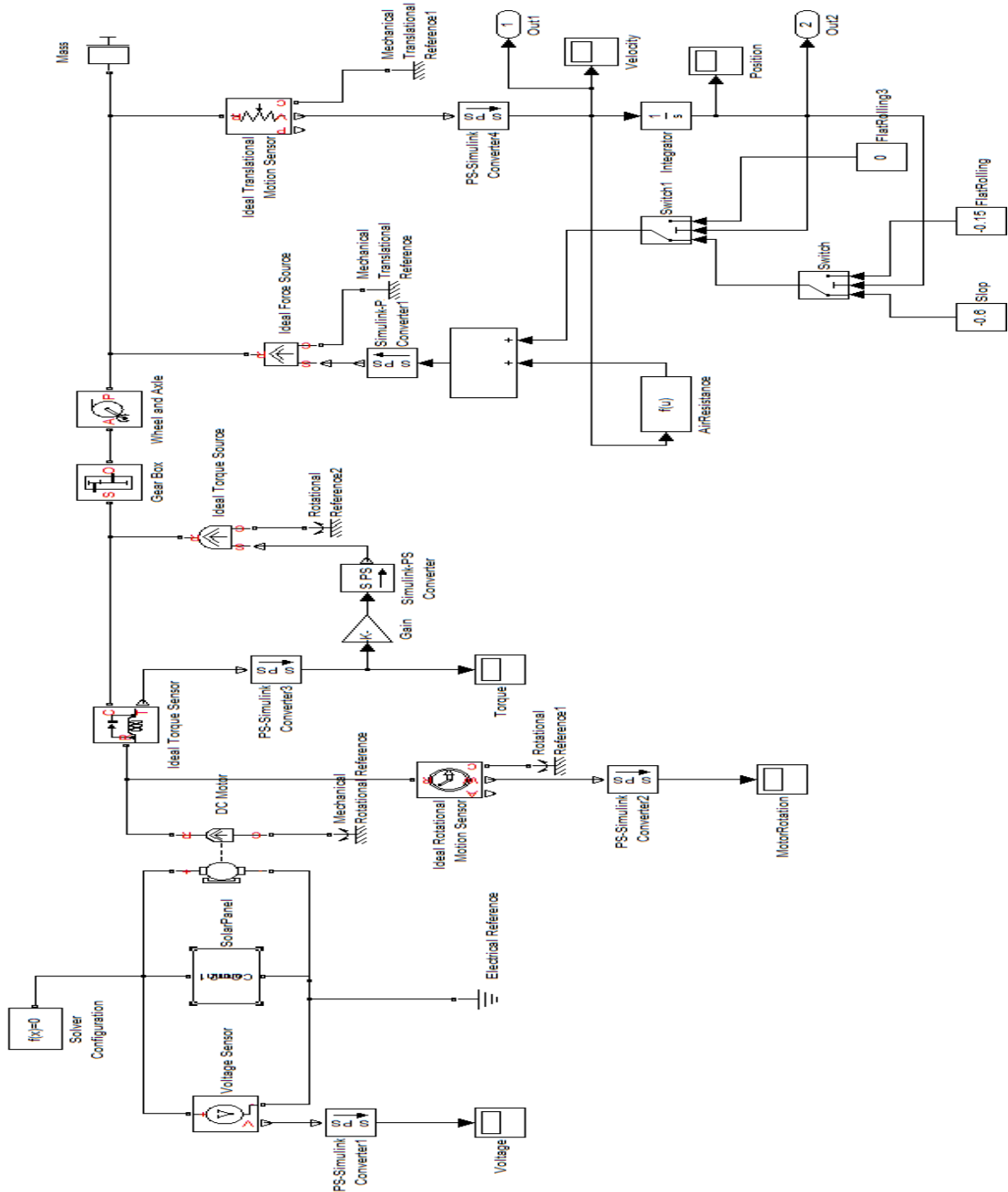


Fig.01 main circuit

- The first part is the Solar Panel. The solar panel is the combination of 15 solar cell that connected in series.

Here is the parameter that we calculated、measured and will be used during the simulation.

- Short-circuit current, I_{sc} : 0.94 A
- Open-circuit voltage, V_{oc} : 0.56 V
- Irradiance used for measurements, I_r0 : 800 W/m²
- Quality factor, N: 1.256

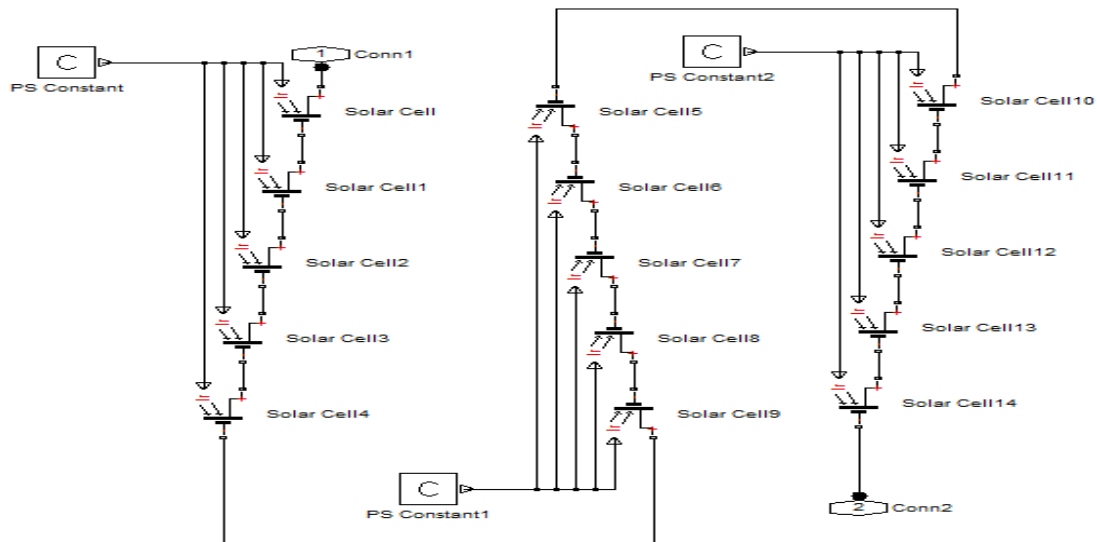


Fig.02

Subsystem-solarpanel

- The second important part is the “bridge” DC motor, which is connected in parallel with the solar panel. Here is the parameter that will be used inside the DC Motor.

- Armature resistance: 3.20 hm
- Armature inductance: 0.222 mH
- Back-emf constant: 0.000893 V/rpm
- Rotor inertia: 4.29 g*cm²
- Rotor damping: 1e-08 N*m/(rad/s)
- Initial rotor speed: 0 rpm

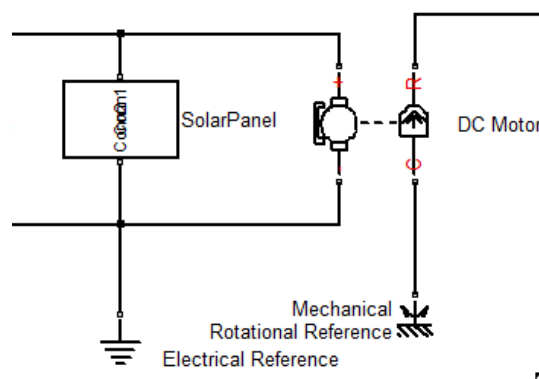


Fig.03 DC Motor

- The third part is the gearbox, axle and wheel and the mass.

When simulation, the following parameter will be used.

Gear ratio: 8

Wheel radius: 0.04 m

Mass: 0.8kg

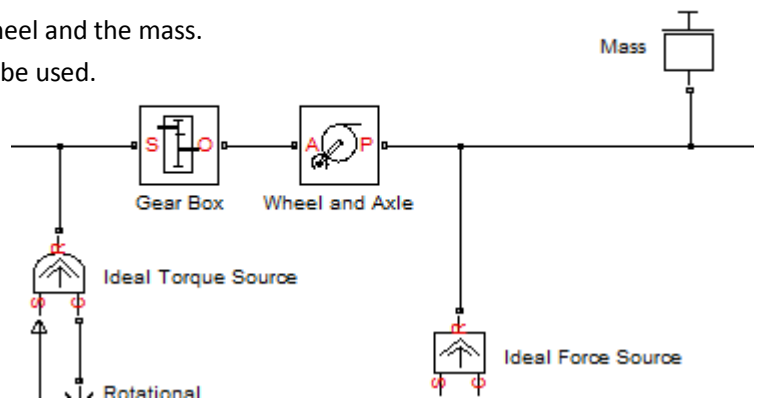


Fig.04 mechanical I Part

There are of course some loses in the motor. So we add a gain to reduce the torque -20%

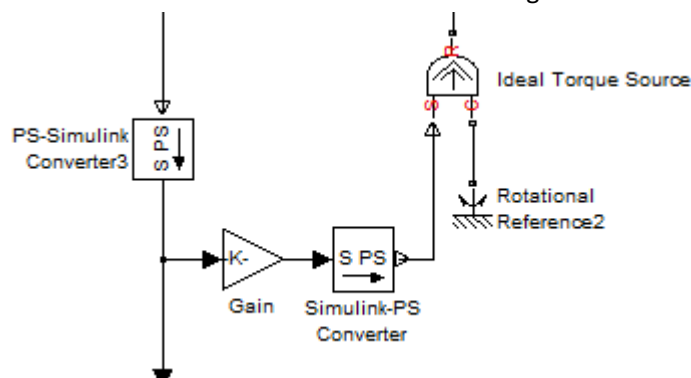


Fig.05 Gain

- The fourth part is the different force in different situation. One is on the flat, Another one is on the slop. Of course that there is no force when the car stands still. The force is as follows.

Rolling resistance: -0.15 N

Air resistance: $-1/2 * 0.5 * 0.05 * 1.29 * V^2$ N

Weight force on the slop: -0.45 N

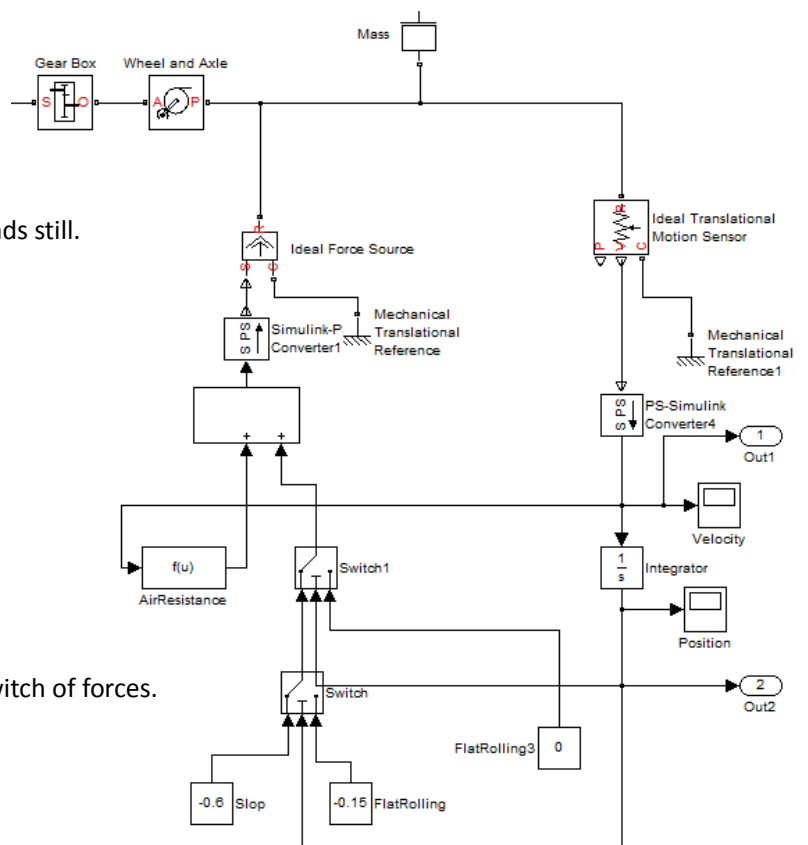


Fig.06 Switch of forces.

● Here is the simulation result.

1. The displacement will first be increased with a curve. After reach the slop. It will increase as a straight line. Our car will finish the race around 5.3 sec.

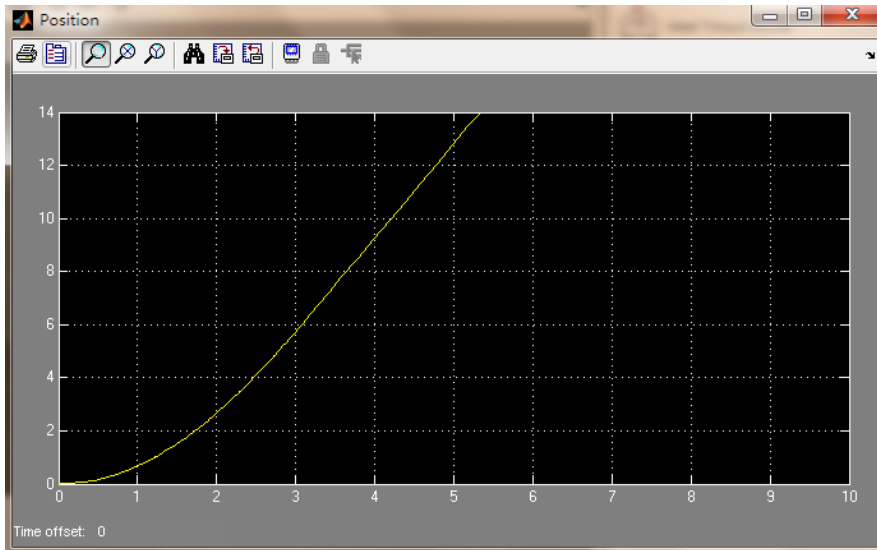


Fig.07 Displacement

2. The velocity will increase until the vehicle reaches the flat. At the break point, that means the vehicle reaches the slop. The max speed is around 3.5m/s.

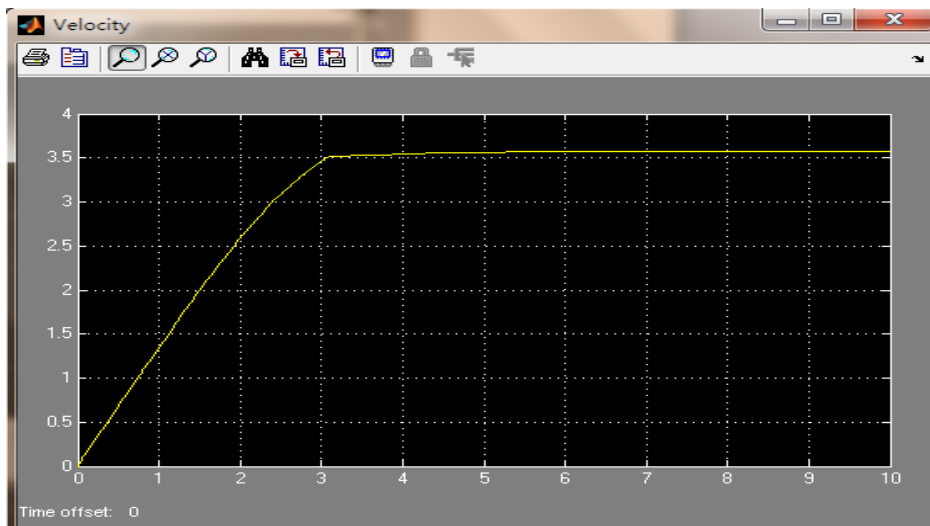


Fig.08 Velocity

3. Rotation of the DC motor will increase until reach the break point. As soon as our car reach the slop, the rotational speed will keep around 700 rad/s, which is the max rotational speed.

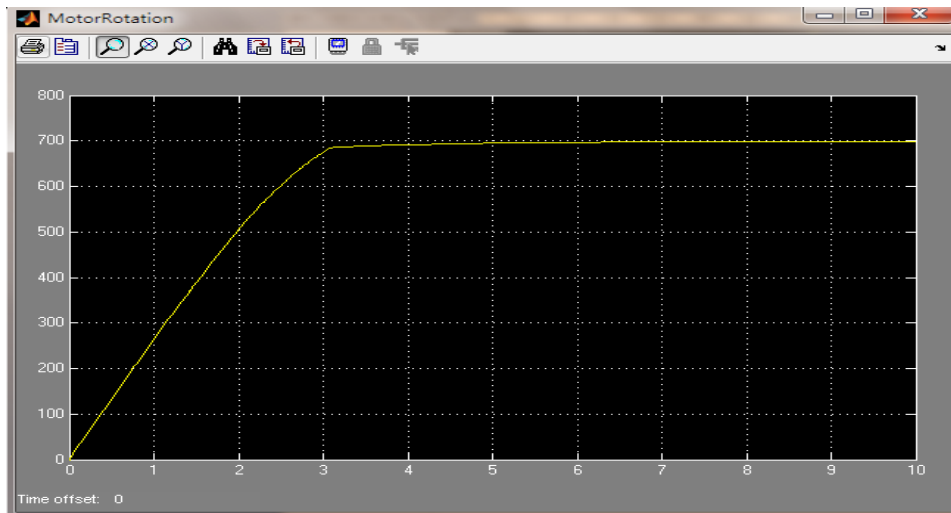


Fig.08 Velocity.

4. The torque will increase immediately when the current goes through the DC motor. And with the speed increases, the torque will decrease. After reach the slop, the speed will keep 3.5m/s, also the torque will keep a constant value around 0.005 N*m.

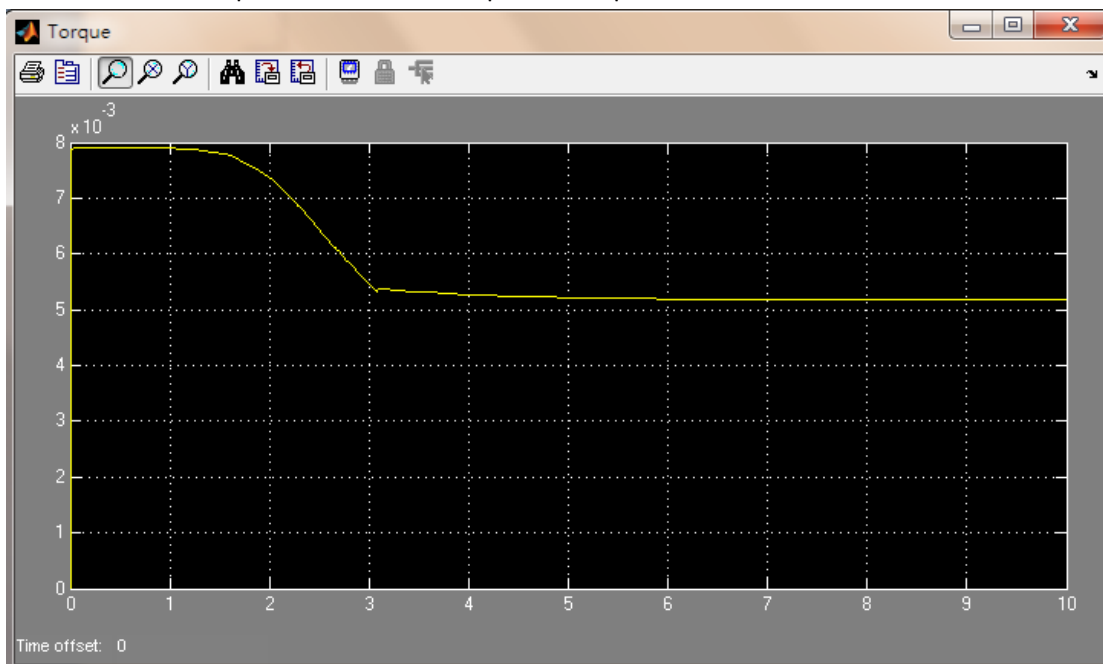


Fig.09 Torque of DC motor

5. Of course it is convenient to simulate the different gear ratio. So we try the different gear ratio, but the other parameter didn't change. Here is the diagram of time and gear ratio that the car will reach the destination. The x-axis is the gear ratio, the y-axis is the time that need to finish the race.

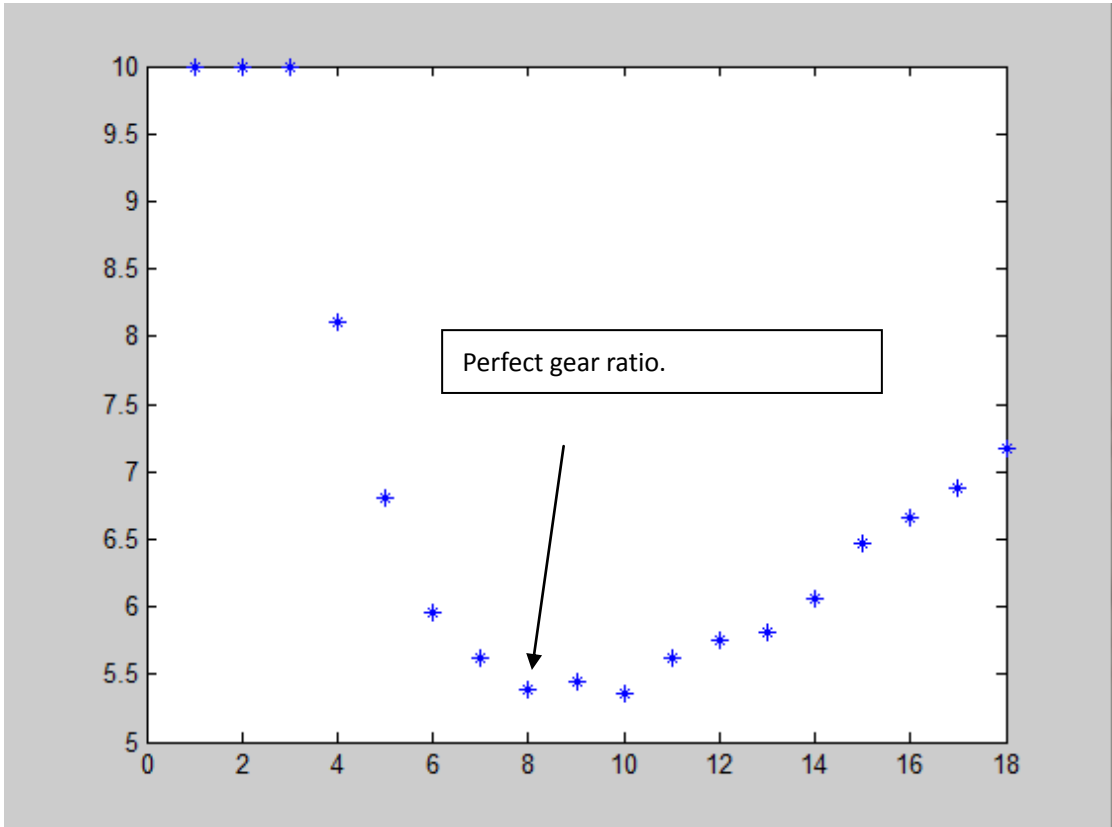


Fig.10 Different Gear ratio.

CASE simulink(part2)

The second part is to simulate our car will rolling down in slop with 1 meter, 3 degrees. After wards rolling freely on the flat.

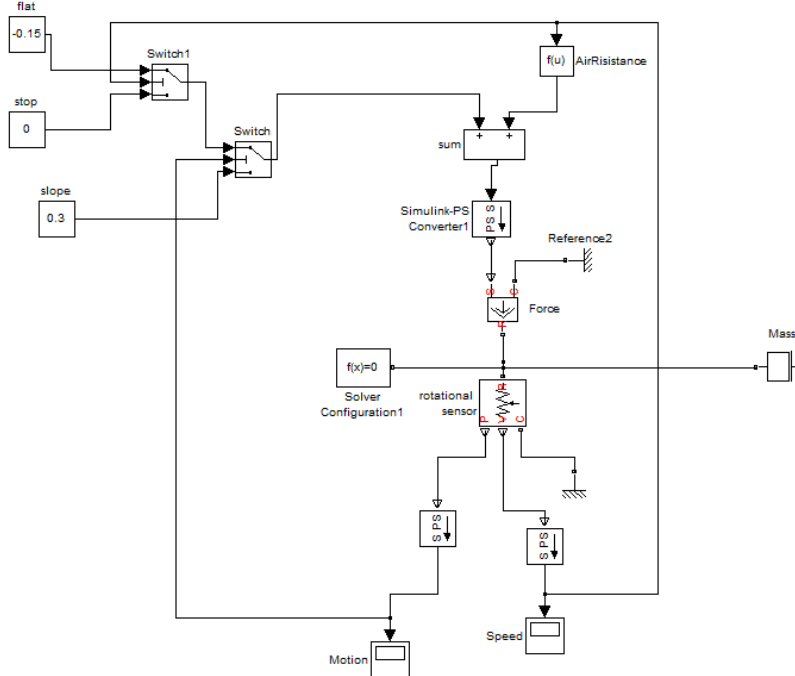


Fig.11 Main circuit 2

- The speed will increase until reach the flat. And will decrease on the flat. The max speed is around 0.85 m/s. It will stop after 6.8 seconds.

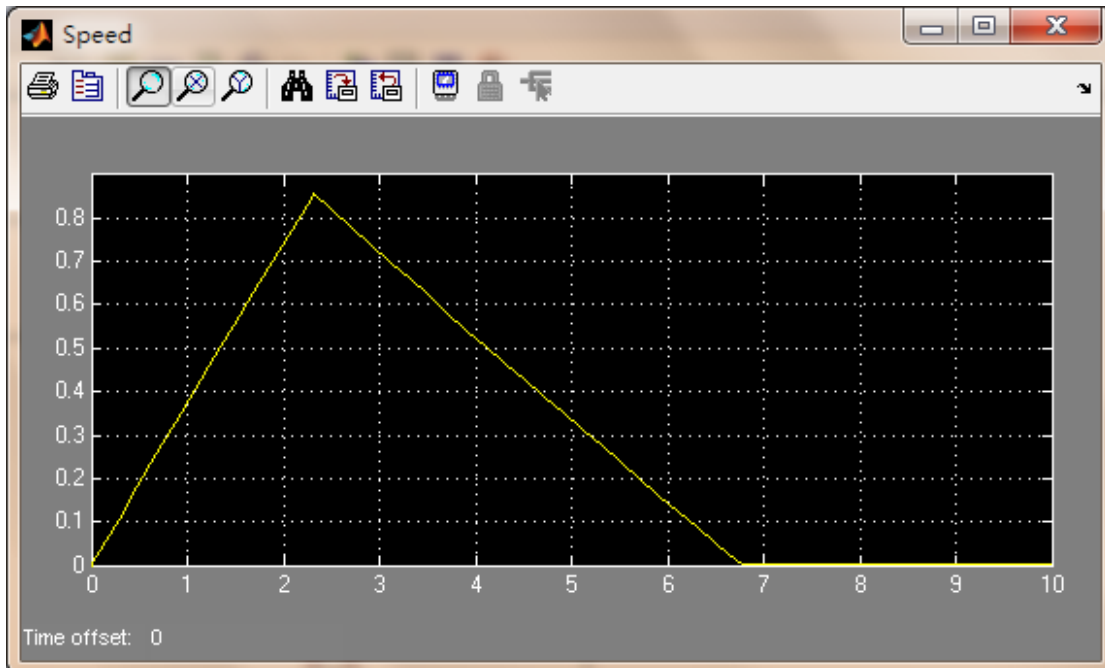


Fig.12 speed2

- The distance that vehicle will move is around 2.9 meters.

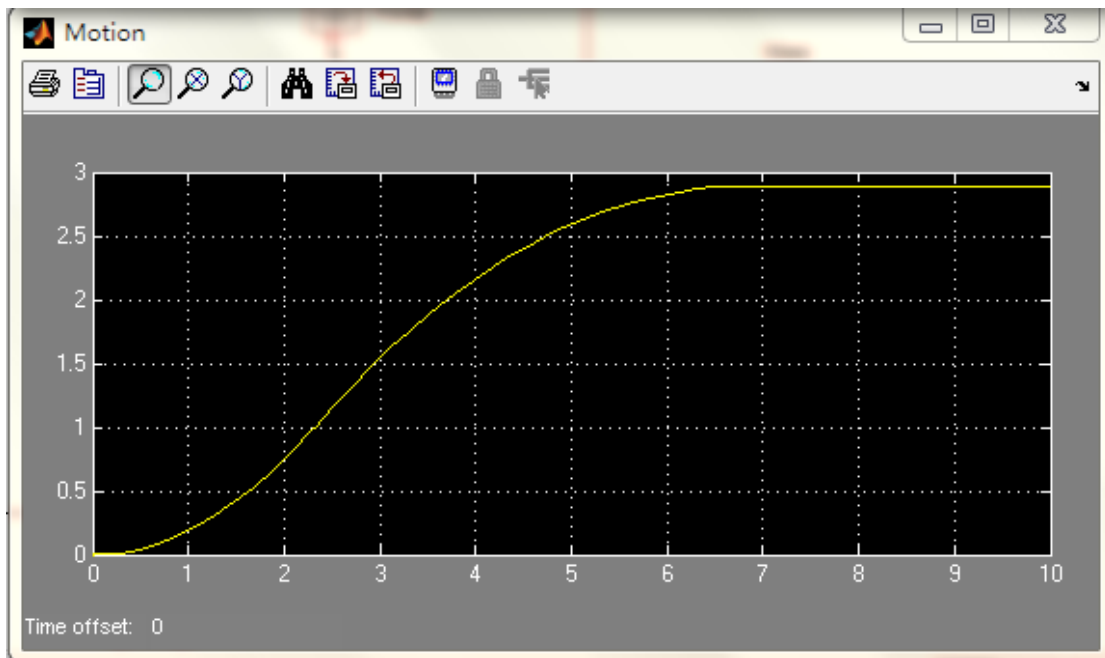


Fig.13 Motion