SIMULINK REPORT

Part 1

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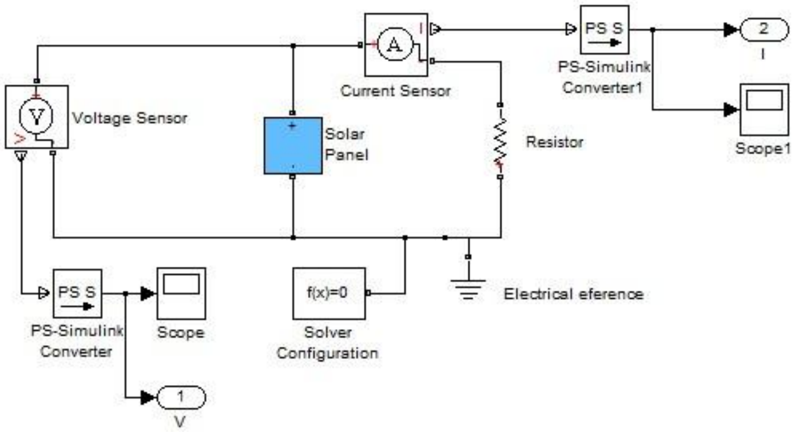
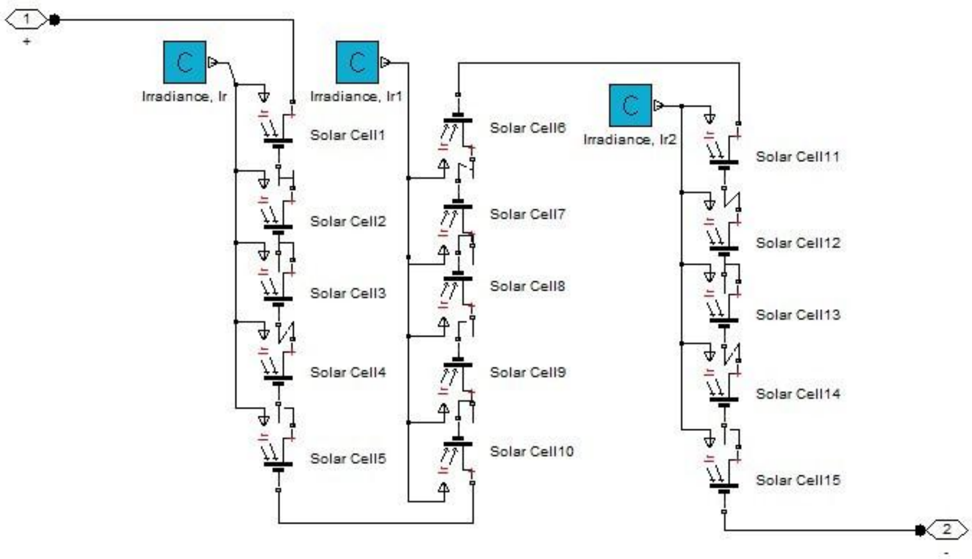
Simulink 1:

Simulate the behavior of the solar panel connected to a resistance between 10 Ohm and 100 Ohm with steps of 10 Ohm.

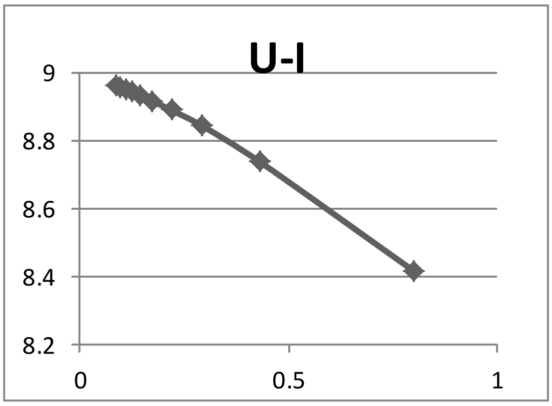


The inside of the solar panel:



After we did the Simulink, we got the voltage and current with different resistor:

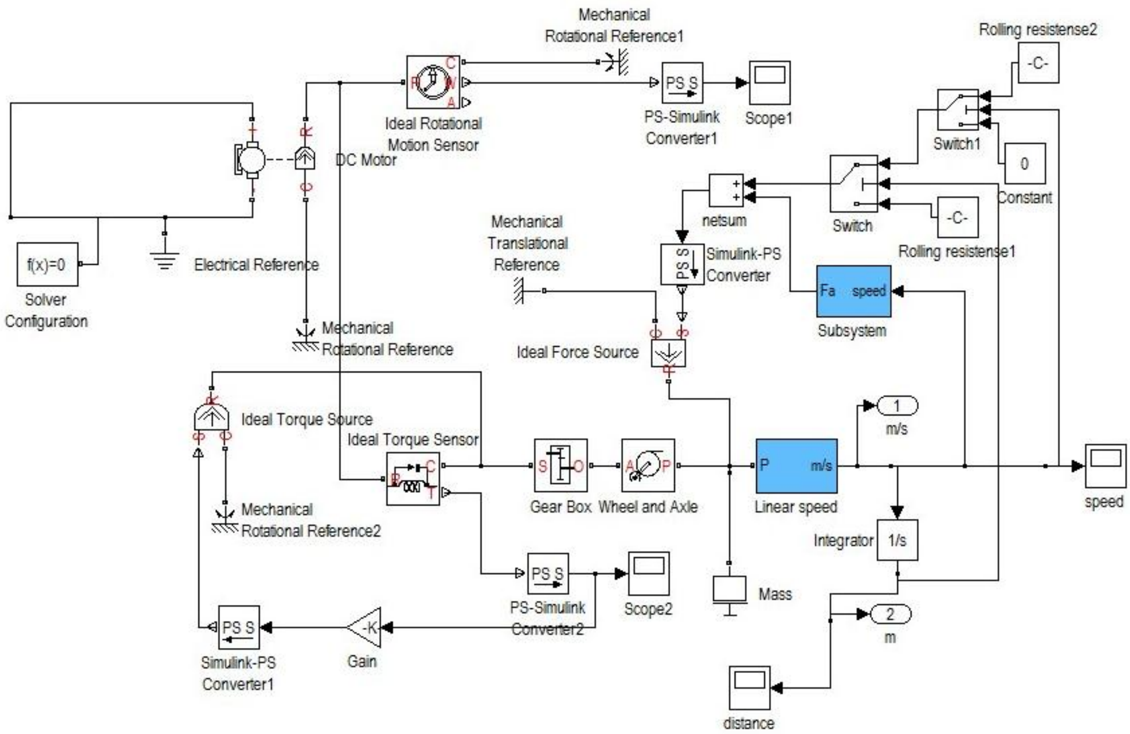
R	I	U	Power
10	0.8041	8.413	6.764893
20	0.4366	8.7319	3.812348
30	0.2947	8.8405	2.605295
40	0.2222	8.8862	1.974514
50	0.1782	8.9115	1.588029
60	0.1488	8.9275	1.328412
70	0.1277	8.9387	1.141472
80	0.1118	8.9468	1.000252
90	0.0995	8.9531	0.890833
100	0.0896	8.958	0.802637



When R=10Ω, the power P=6.764893W is the maximal power transfer.

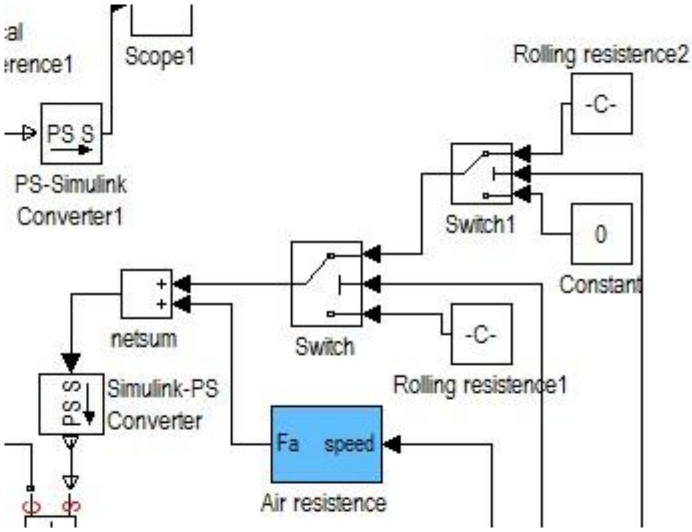
SIMULINK 2

Simulate the behavior of your vehicle with DC-motor, but without solar panel. Extend the model with the different load torques

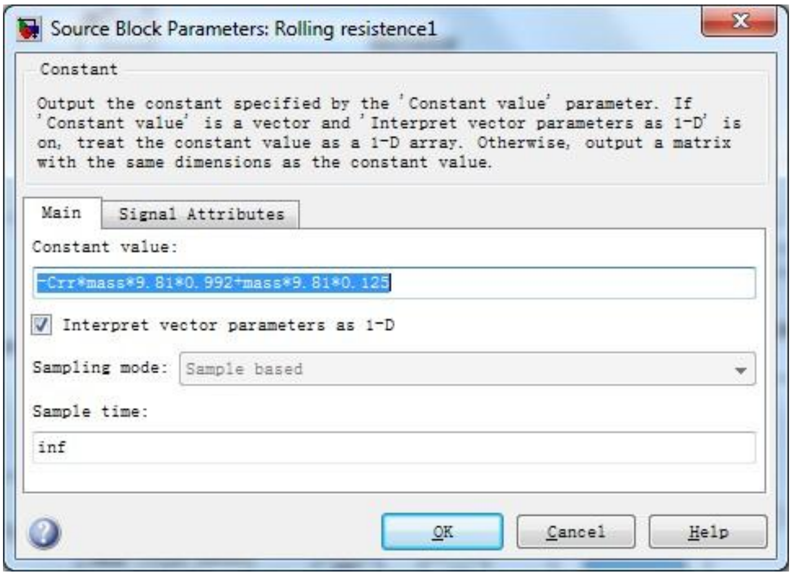


This is the situation the SSV with DC-motor, without solar panel, starts at a height of 0.25 m and rolls down for a distance of 2 m.

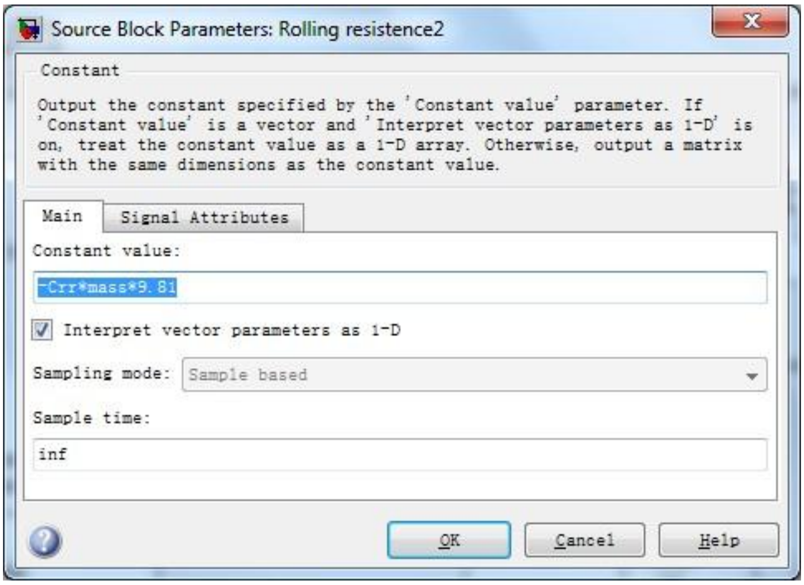
There are two processes with different resistance from the SSV rolling down to stop, so we use a switch to separate these two processes.



First process is the SSV rolls down for 2m. At this situation the rolling resistance1 is -Crr*mass*9.81*cos θ +mass*9.81*sin θ



After 2m the rolling resistance2 will be -Crr*mass*9.81,until the velocity equals to 0.

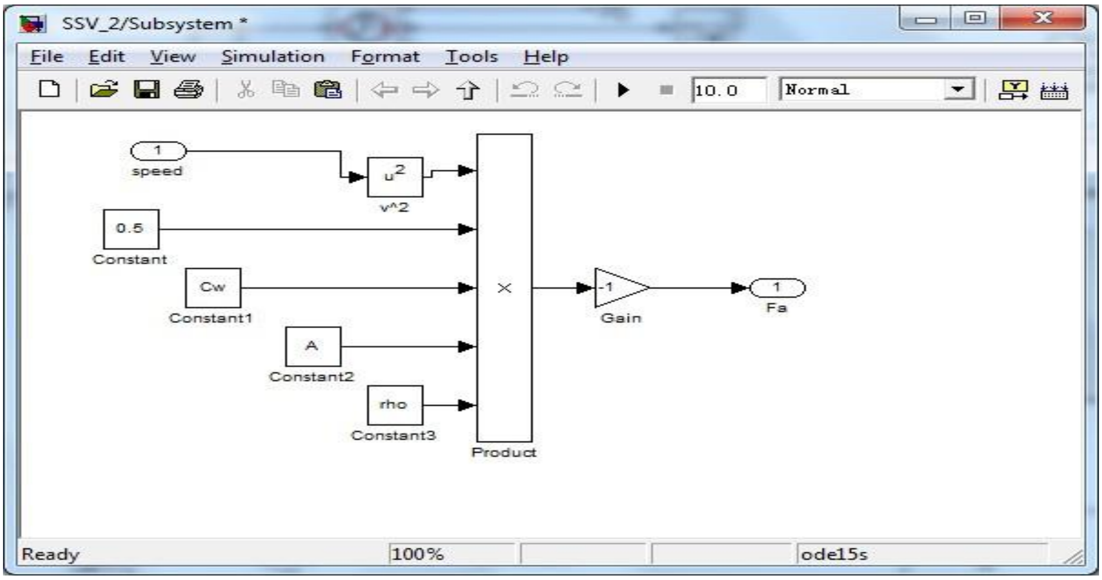


When the velocity becomes 0, the rolling resistance will be 0 also. And that's why we use another switch "switch1".

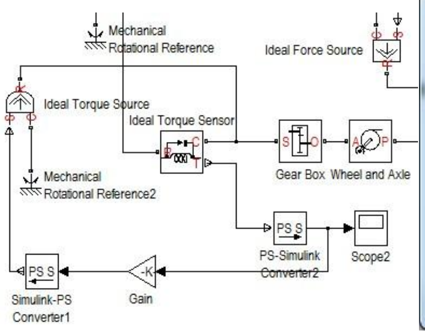
For "switch", if the distance is larger than 2m, the switch will choose "switch1";

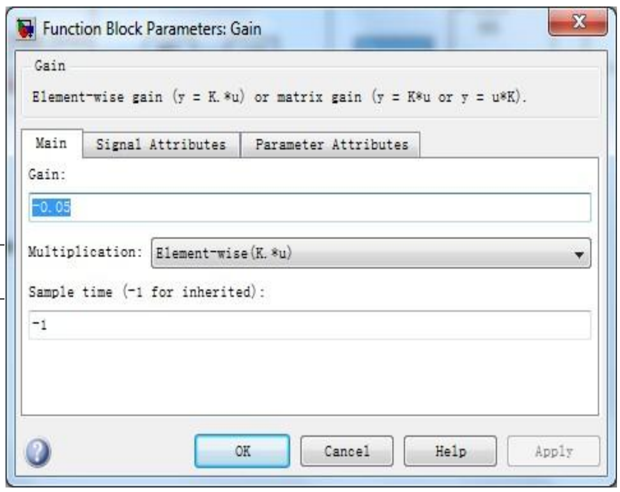
For "switch1", if the velocity =0, the switch will choose constant 0. And the SSV will stop, we can get the largest distance.

This is the subsystem of air resistance. $Fw = ½ \cdot Cw \cdot A \cdot \rho \cdot v^2$

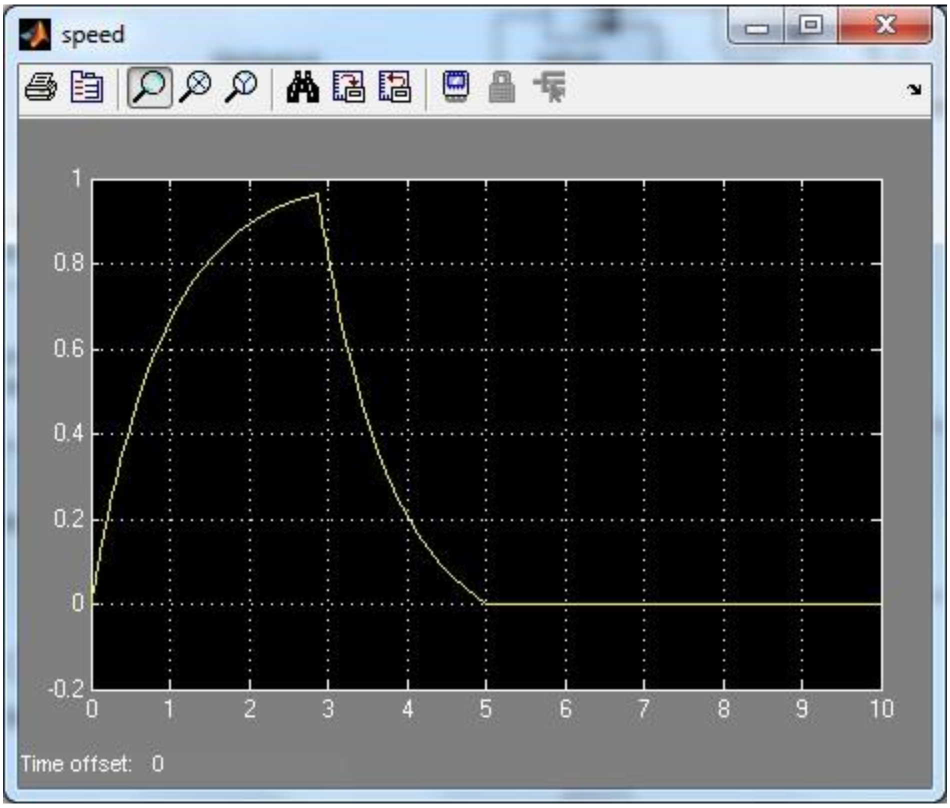


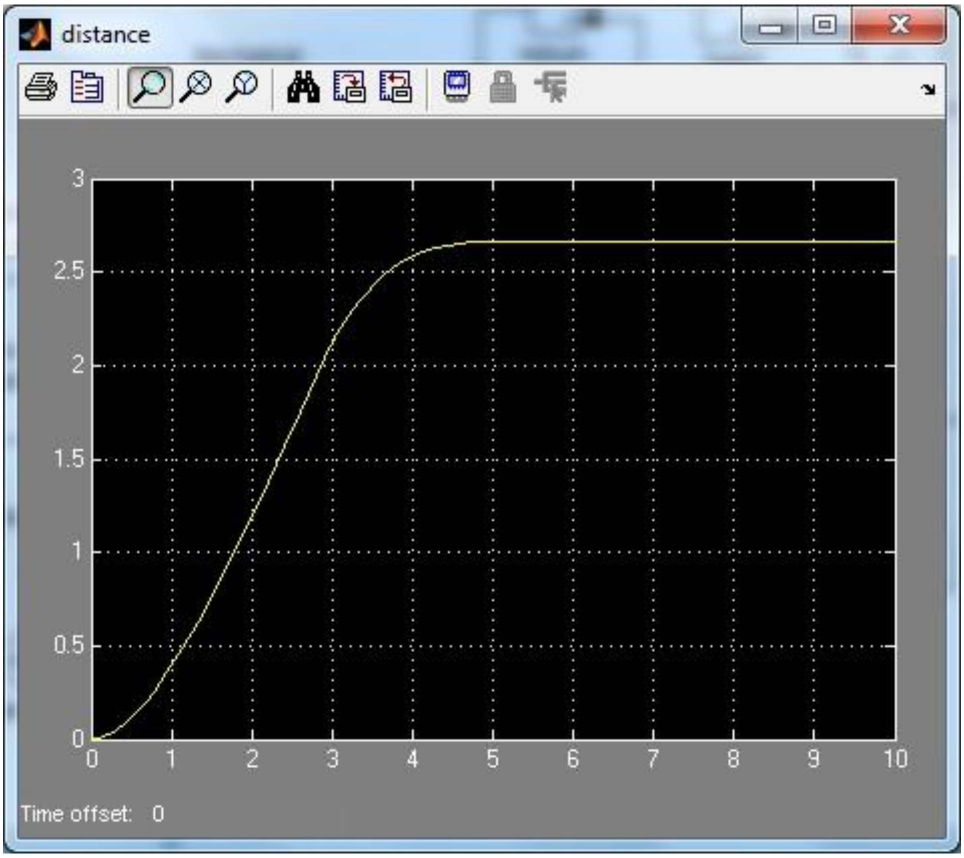

```
%%% Motor parameters
Ra = 3.32;     % ohm
Km = 0.00855;     % Nm/A
La = 2.2e-4;     % H
Im = 4.1;     % g*cm^2
Cm = 0e-4;     % N*m/(rad/s)
%%% SSV parameter
mass = 1;  % kg
Cw  = 0.5;
A   = 0.02;   % m^2
rho = 1.29;   % kg/m^3
Crr = 0.012;
%%% Wheel radius
r = 0.035; % m
```





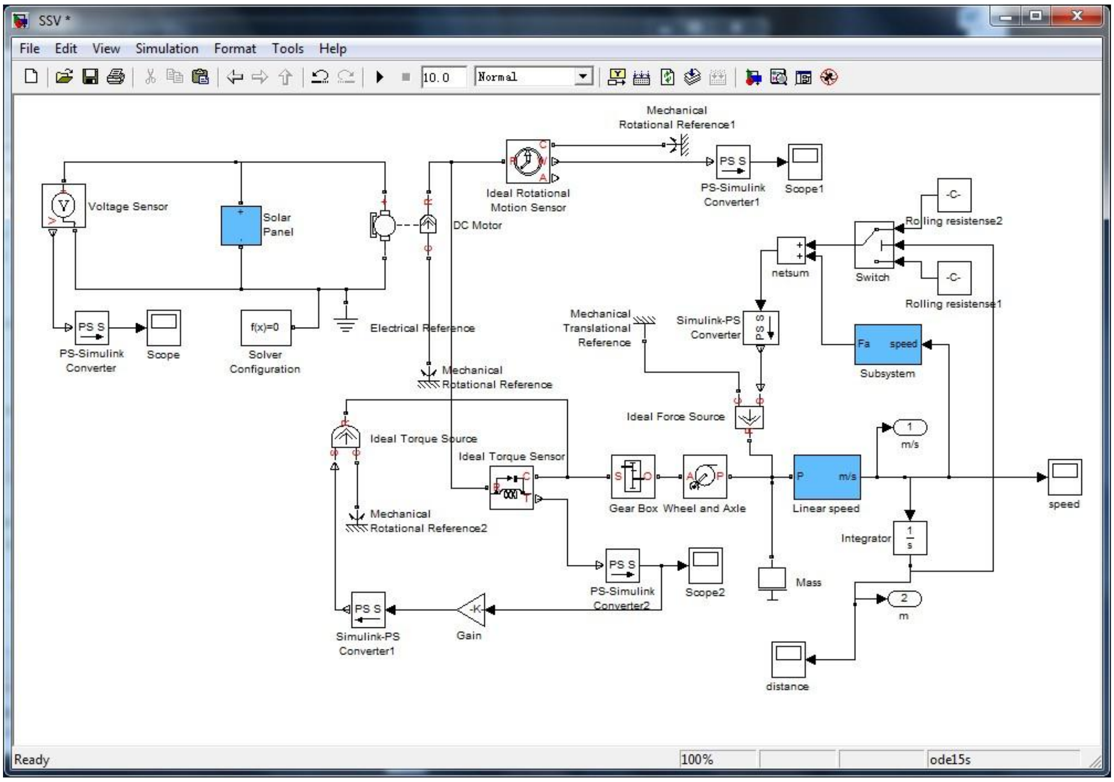
With a certain load torque we get the result below





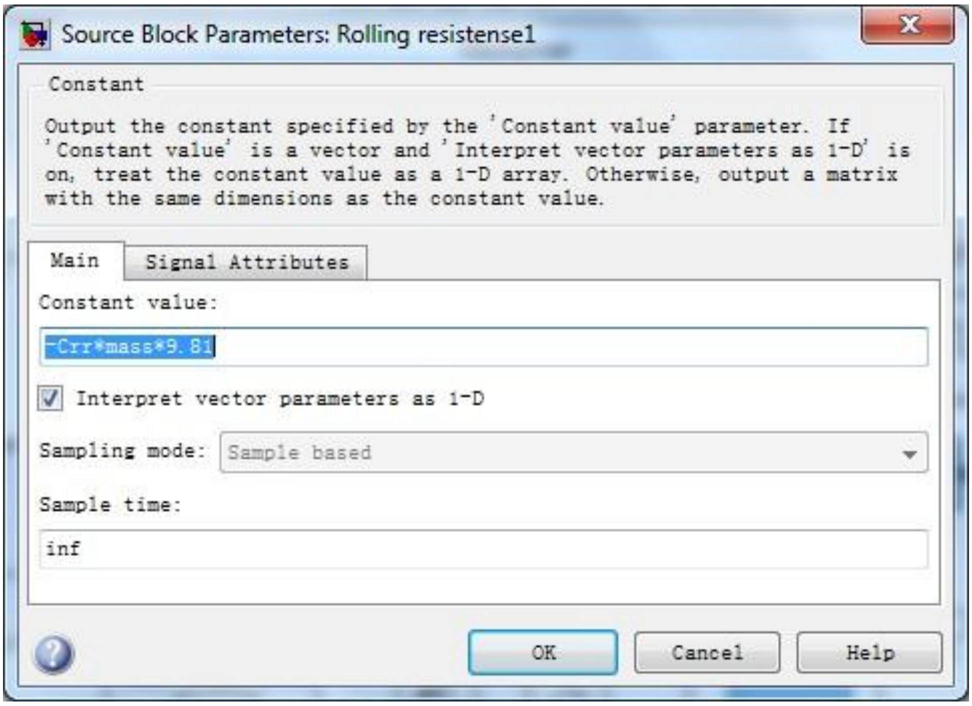
the total distance we can get from the figure is 2.67m.

SIMULINK 3



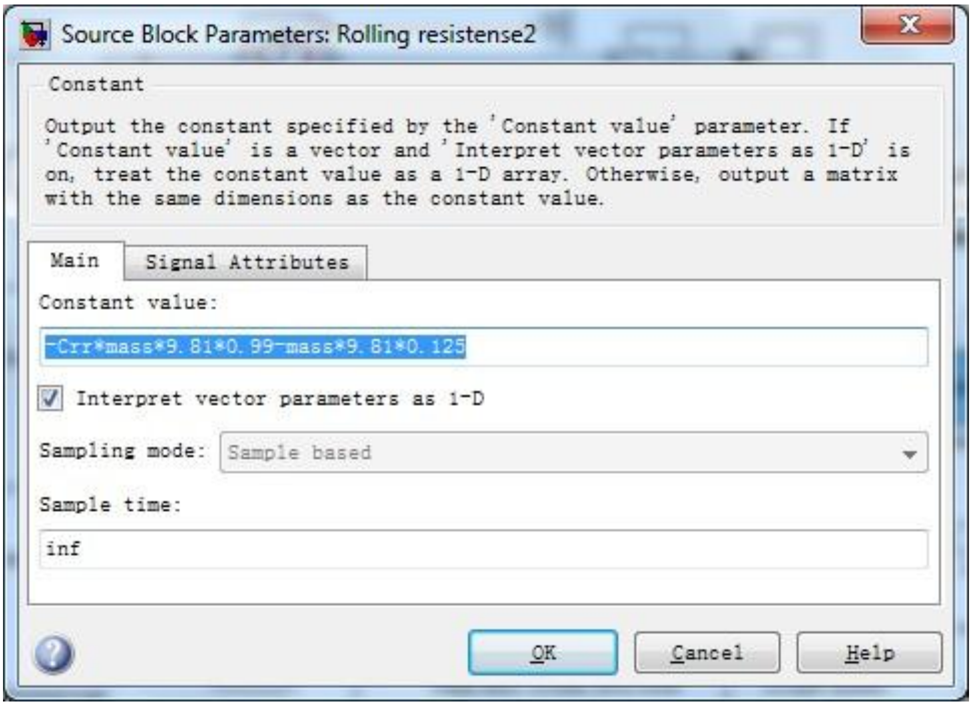
We keep most part of the Simulink 2, only add a solar panel, and change the rolling resistance.

During the race, for the first 10m the rolling resistance1 is

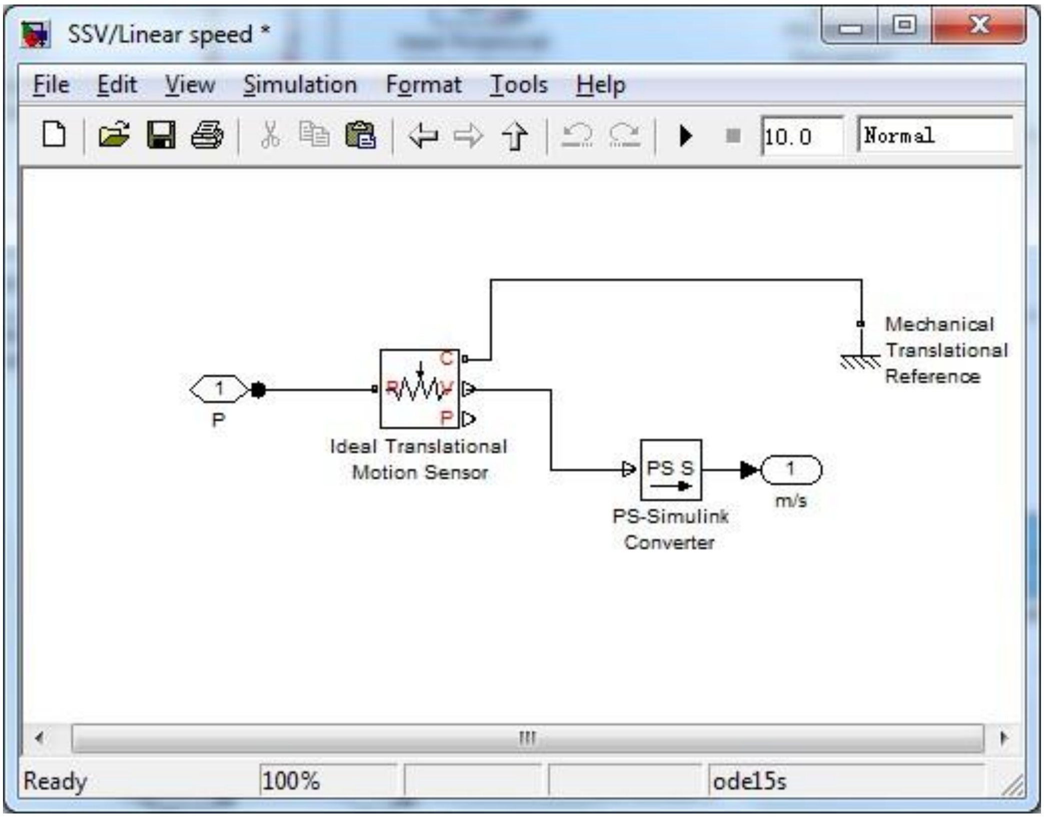


For the last 4m the rolling resistance changes to

-Crr*mass*9.81*cos θ -mass*9.81*sin θ



The subsystem of the linear speed

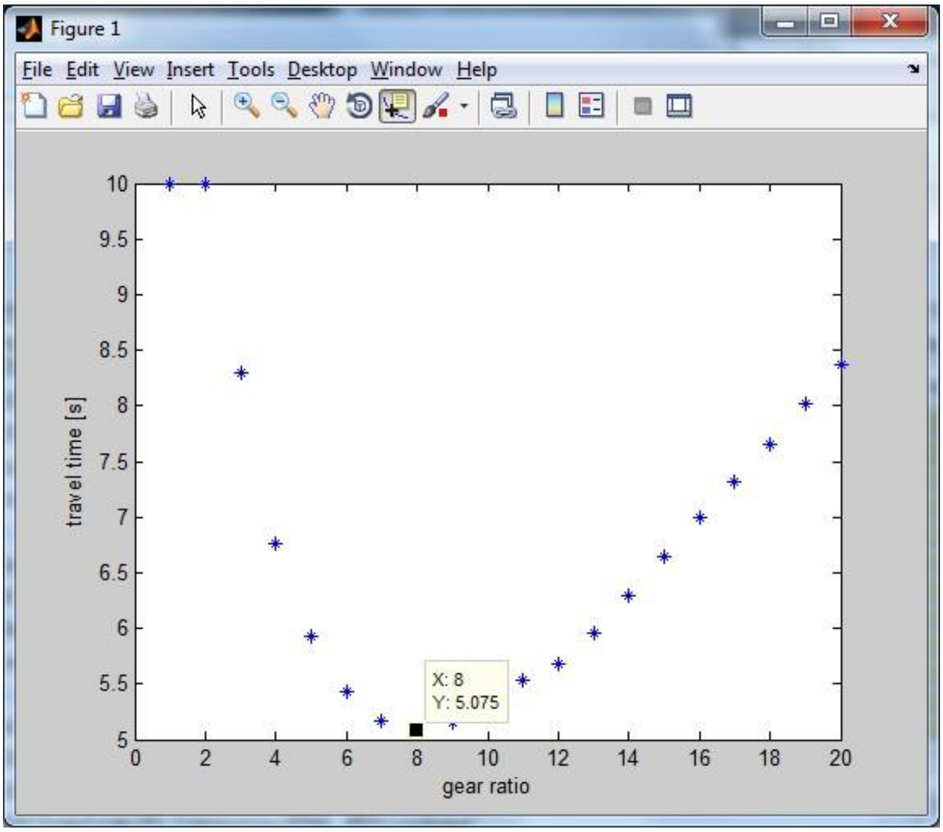


The code in script

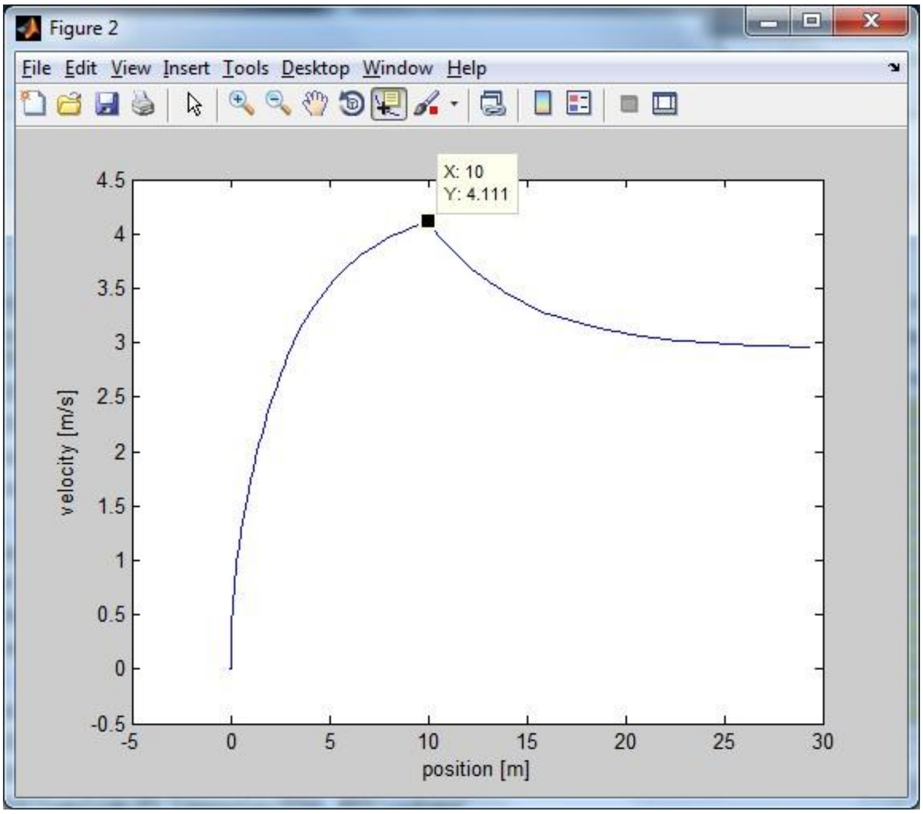
Editor - D:\Study\EE4\Matlab\New folder\SSV_script.m

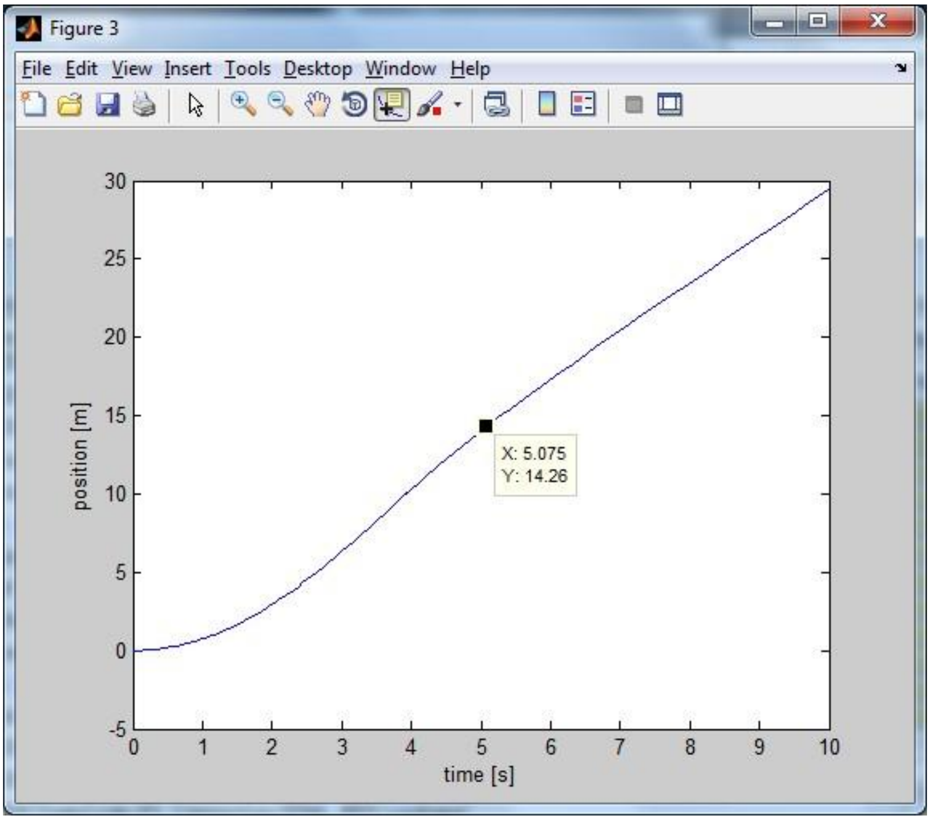
```matlab
%%% Solar Power
Ir = 800 ;    % solar irradiance [W/m^2]
Is = 1e-8;    % saturation current [A]
Isc = 0.88;   % short circuit current [A]
Voc = 0.6;  % Open circuit voltage [V]
Ir0 = 800;  % irradiance used for measurements [W/m^2]
m = 1.015;    % diode quality factor
%%% Motor parameters
Ra = 3.32;     % ohm
Km = 0.00855;     % Nm/A
La = 2.2e-4;     % H
Im = 4.1;     % g*cm^2
Cm = 0e-4;     % N*m/(rad/s)
%%% SSV parameter
mass = 1;  % kg
Cw  = 0.5;
A   = 0.02;   % m^2
rho = 1.29;   % kg/m^3
Crr = 0.012;
%%% Wheel radius
r = 0.035; % m
%%% Track
% put parameters track here %
result=[];
tn=[];
for ratio=1:20
    ratio
    tn=[tn ratio];   % Extend vector with current ratio
    sim('SSV',10);   % Simulate Simulink model for 10 s
    [i,j]=find(yout(:,2)>14);   % find when position of 14 m is achieved
    if isempty(i)
        result = [result 10];  % if not achieved take time = 10 s
    else
        result = [result tout(i(1))];   % put travel time in vector
    end

end
figure(1)
plot(tn,result,'*') % plot gear ratio versus travel time
xlabel('gear ratio')
ylabel('travel time [s]')
[opt,i]=min(result); % find minimal travel time
ratio=tn(i); % select gear ratio corresponding to the minimal travel time
% simulate once more with best gear ratio and make a few plots
sim('SSV',10);
figure(2)
plot(yout(:,2),yout(:,1))
xlabel('position [m]')
ylabel('velocity [m/s]')
figure(3)
plot(tout,yout(:,2))
xlabel('time [s]')
ylabel('position [m]')
```

This figure shows the relation between gear ratio and travel time.



We can easily know that the travel time is shortest (5.075s) when gear ratio is 8. Then we can get





4. The Simulink is a quite easy and effective way to find the proper gear ratio. The calculation will be very complex without Simulink. And also the Simulink can give us figures we want immediately. We can understand the motion more directly by the figures.