RR Target Simulation

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English units

This simulation uses English units.

unit	desc
ft	length
lbf	weight
slug	mass
s	time
degrees	angle

Simulation Parameters

initial parameter	value
target range (X)	1000
target altitude (Z)	20000
target velocity	490
target pitch	0
RR range (X)	0
RR altitude (Z)	0
RR velocity	15
RR pitch	90

The simulation as described in "RR Target Simulation Model Design" was run using the model data and simulation parameters. The simulation starts as target vehicle passes overhead at 290 knots at 20,000 feet and the RR vehicle launches vertically from the ground after the target is down range. Because the RR vehicle simulation uses wind forces, some small initial velocity was required although in reality it would launch from zero velocity.

```
clear;
load("RR.mat");
load("target_sim.mat");
```

Time to target

```
%simulation time
max(target_sim_out.tout)
```
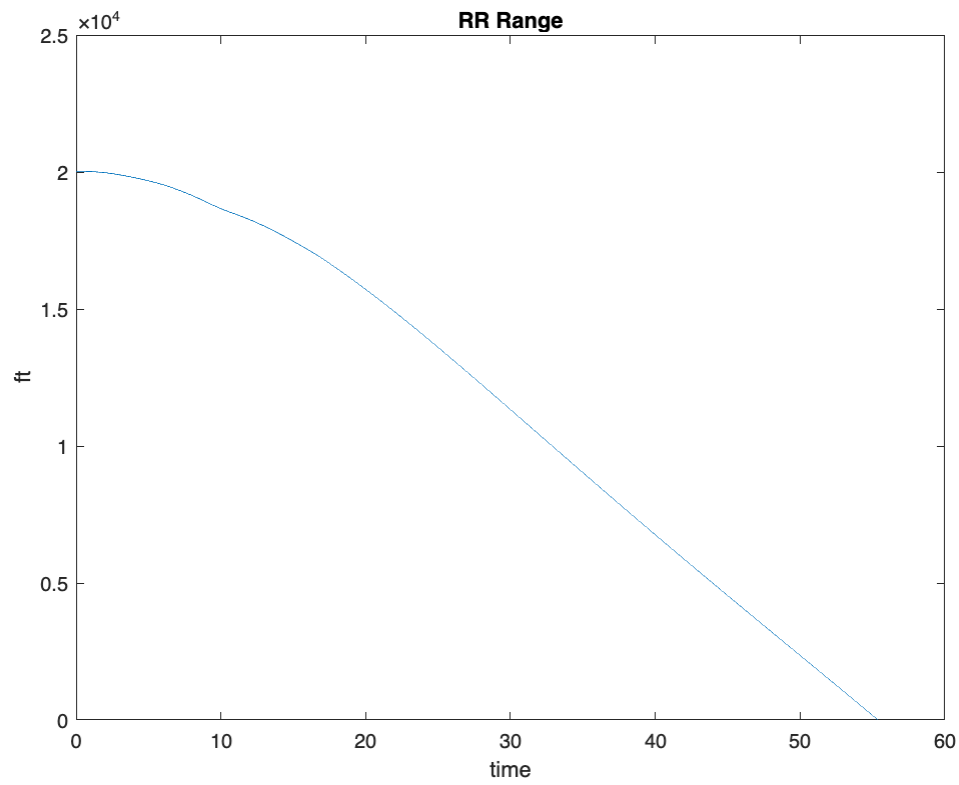
```
ans = 55.3649
```

It takes less than a minute for the RR vehicle to reach the target.

Range

```
% max range
max(target_sim_out.yout{3}.Values.Data(:,[1]))
```

ans = 2.0026e+04

```
plot(target_sim_out.yout{3}.Values.Time, ...
     target_sim_out.yout{3}.Values.Data(:,[1])');
title('RR Range');
xlabel('time');
ylabel("ft")
```

Position

```matlab
% max down range
max(target_sim_out.yout{1}.Values.Data(:,[1]))
```

```
ans = 2.8099e+04
```

The target vehicle intercept happens 28,100 ft down range.

```matlab
plot(target_sim_out.yout{1}.Values.Time, ...
    target_sim_out.yout{1}.Values.Data(:,[1])', ...
    target_sim_out.yout{2}.Values.Time, ...
    target_sim_out.yout{2}.Values.Data(:,[1])');
title('Vehicle Distance Down Range');
xlabel('time');
ylabel("ft");
legend({'Target','RR'},'Location','northwest');
```

Vehicle Distance Down Range
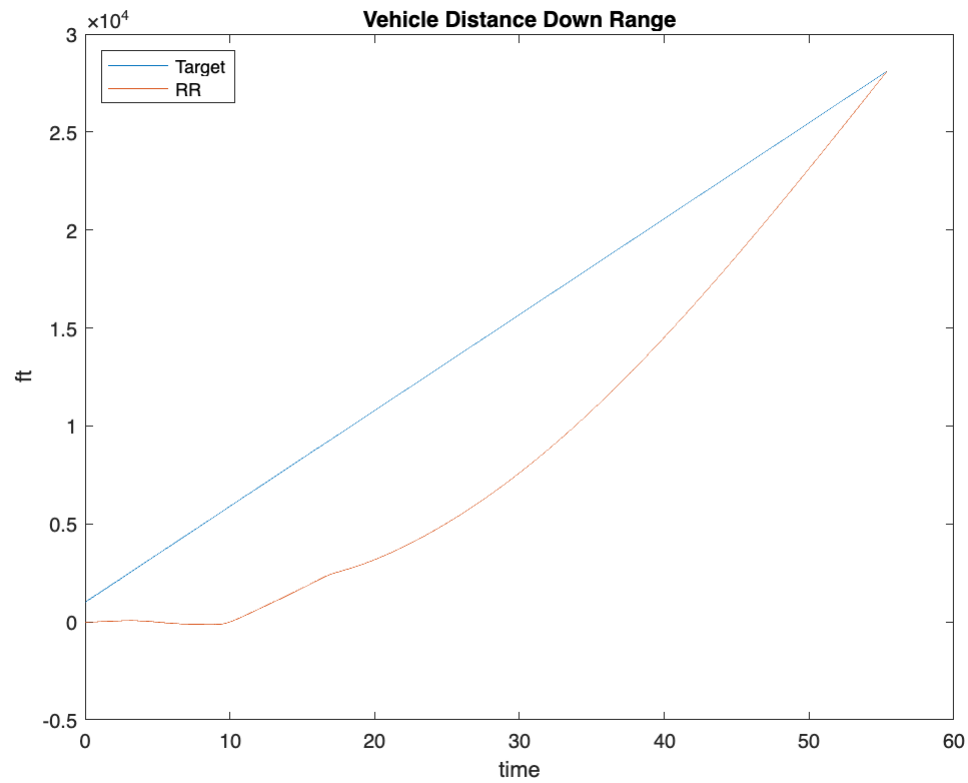
```
plot(target_sim_out.yout{1}.Values.Time, ...
    target_sim_out.yout{1}.Values.Data(:,[3])'*-1, ...
    target_sim_out.yout{2}.Values.Time, ...
    target_sim_out.yout{2}.Values.Data(:,[3])'*-1);
title('Vehicle Altitude');
xlabel('time');
ylabel("ft");
legend({'Target','RR'},'Location','northwest');
```
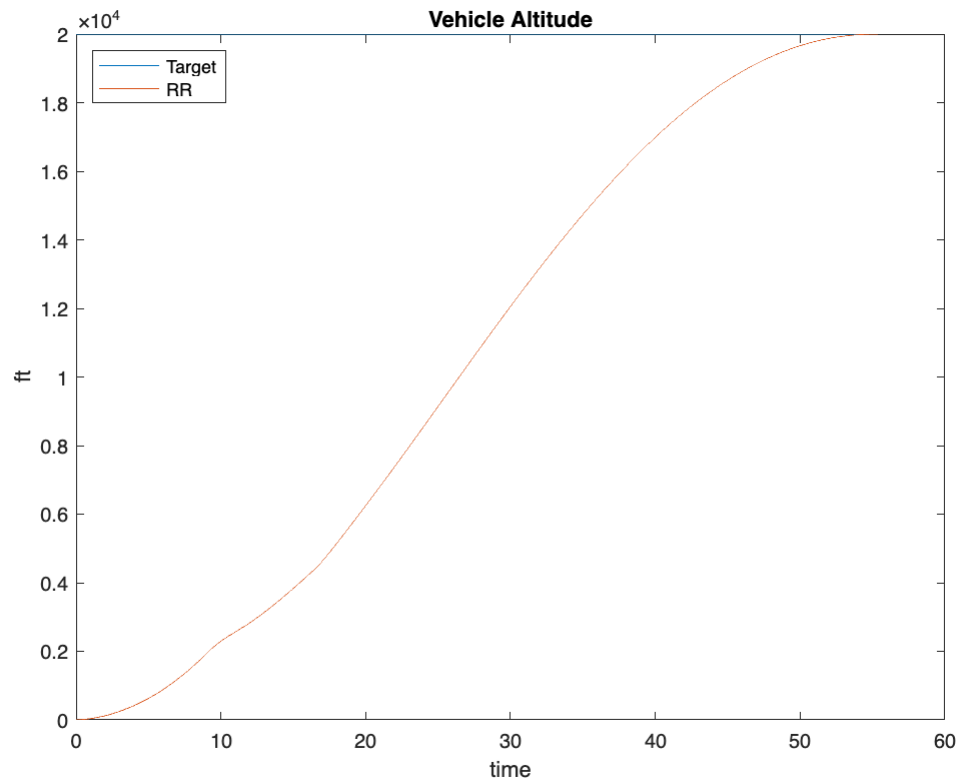
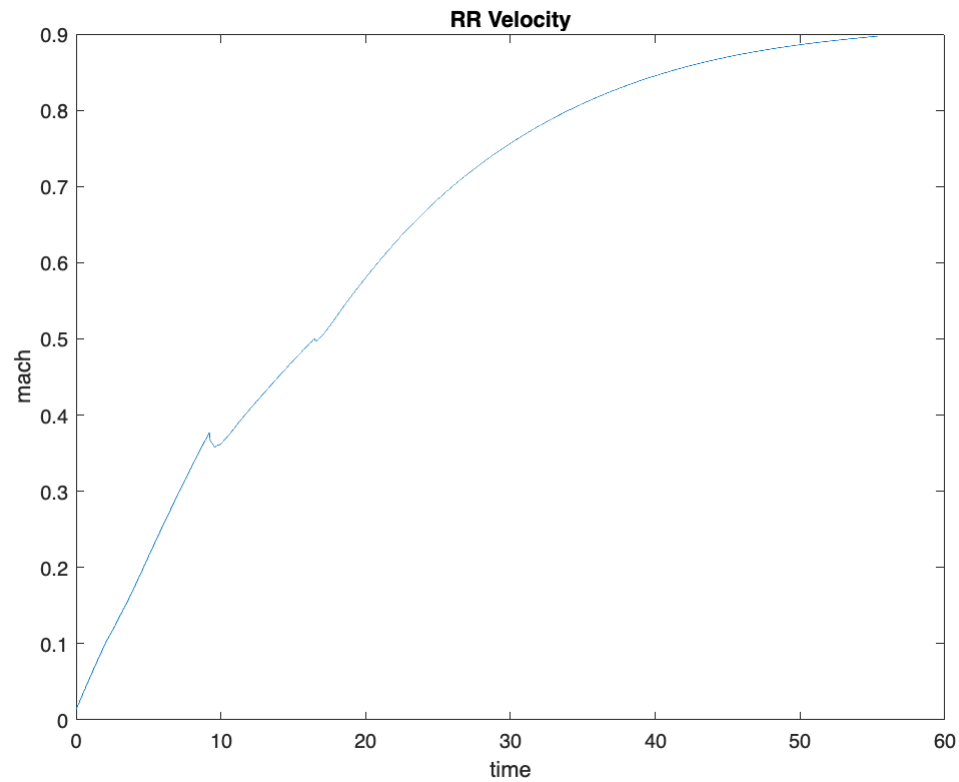The RR vehicle climbs to 20,000 feet to intercept the target.

Velocity

```
% max velocity
max(target_sim_out.yout{5}.Values.Data(:,[1]))
```

```
ans = 0.8973
```

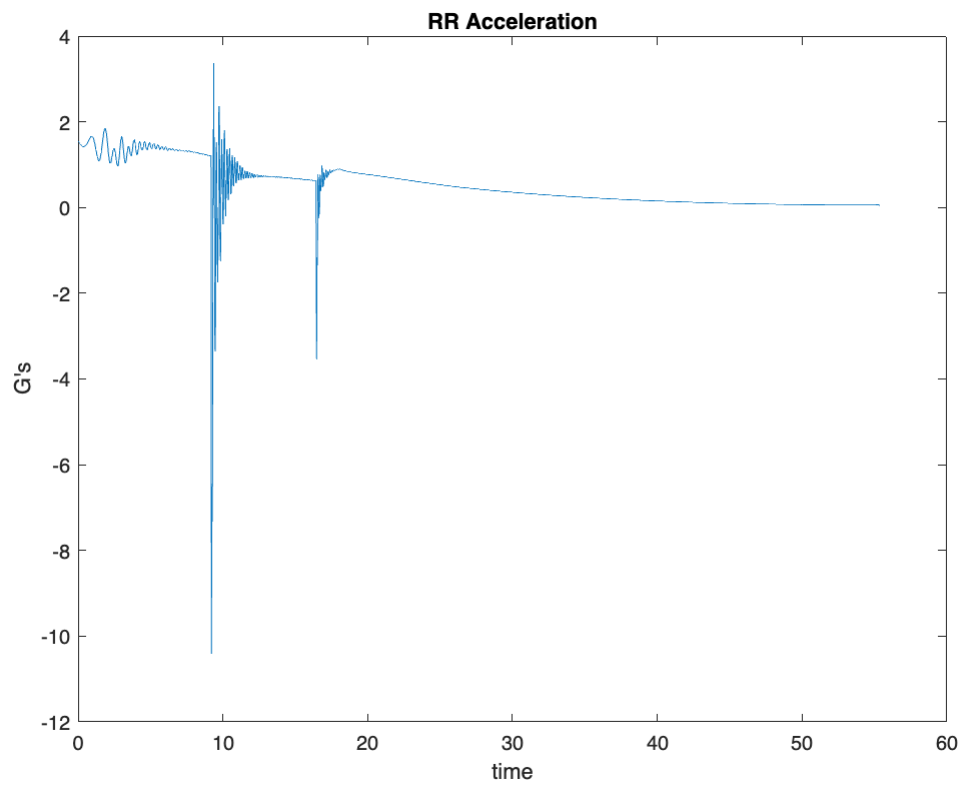The RR vehicle approaches its max velocity ~ mach 0.9 as it intercepts the target.

```
plot(target_sim_out.yout{5}.Values.Time, ...
    target_sim_out.yout{5}.Values.Data(:,[1])');
title('RR Velocity');
```
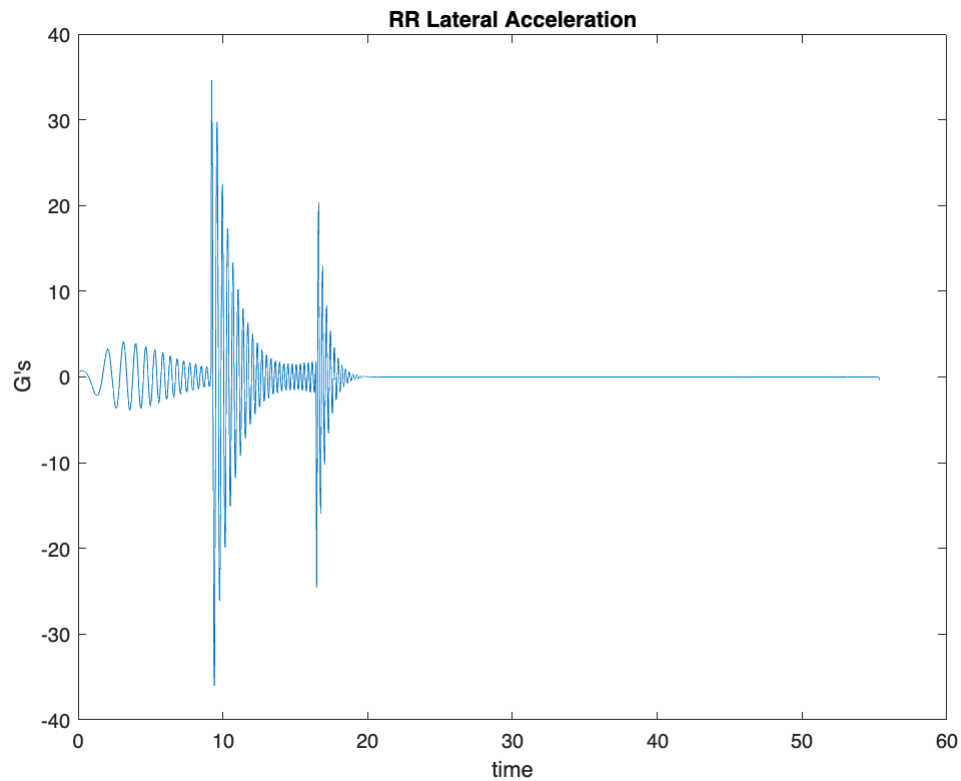
```
xlabel('time');
ylabel("mach");
```


RR Velocity

Acceleration

```
plot(target_sim_out.yout{4}.Values.Time, ...
     target_sim_out.yout{4}.Values.Data(:,[1])'/G);
title('RR Acceleration');
xlabel('time');
ylabel("G's");
```

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```
plot(target_sim_out.yout{4}.Values.Time, ...
    target_sim_out.yout{4}.Values.Data(:,[3])'/G);
title('RR Lateral Acceleration');
xlabel('time');
ylabel("G's");
```

RR Lateral Acceleration

Due to the model simplicity in its control and autopilot design the pitch change commands cause unnecessarily violent G forces on the RR vehicle in this simulation. If more time was available PID rate control and different PID settings for different flight modes like launch, cruise, and target would be added. Additionally, a linear actuator block would have been added to the model to move the elevons. These changes would reduce or eliminate oscillations and limit the G forces. A controller that uses lateral G forces to feed back into pitch control when tracking the target would be explored next.