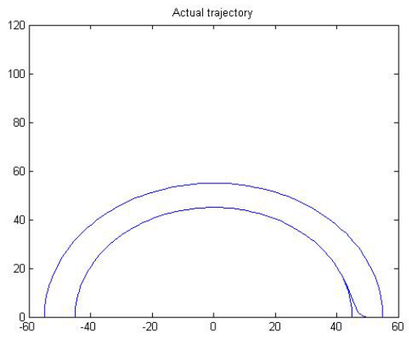
Minimum Time Cornering of a Car

ABSTRACT

Application of optimal control to race car manueveres has been an active area of research since the dawn of F1 racing. In this project, methods of optimal control have been applied to obtain the best driver stratergy to go around a corner in minimal time. When it comes to finding the best driver stratergy, a simple car model would be sufficient. In this project, we started with a simple model of a car and added modules to the car model as we progressed. Simulations were performed for a car going around a U turn and the effect of the different models have been presented.

MODEL 1

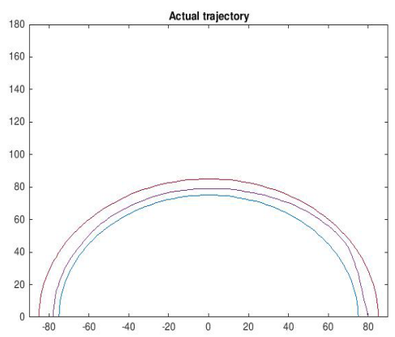
Time=157.079 s



$$\dot{s_n}(t) = V sin(\delta(t))$$
$$\dot{s_t}(t) = \frac{V cos(\delta(t))}{1 - \frac{s_n(t)}{R}}$$

R=50m
W=10m
V_o=1m/s

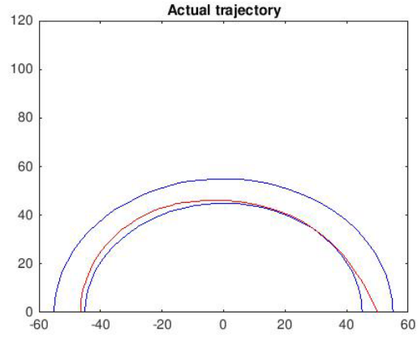
Time=24.1276 s



R=80m
W=2m
V_o=10m/s

MODEL 2

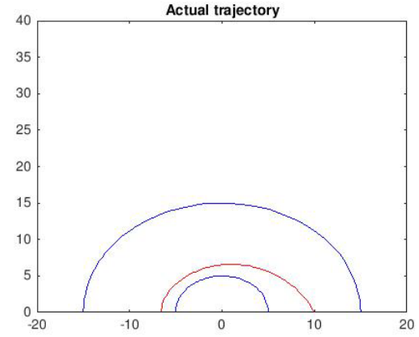
Time=6.3404 s



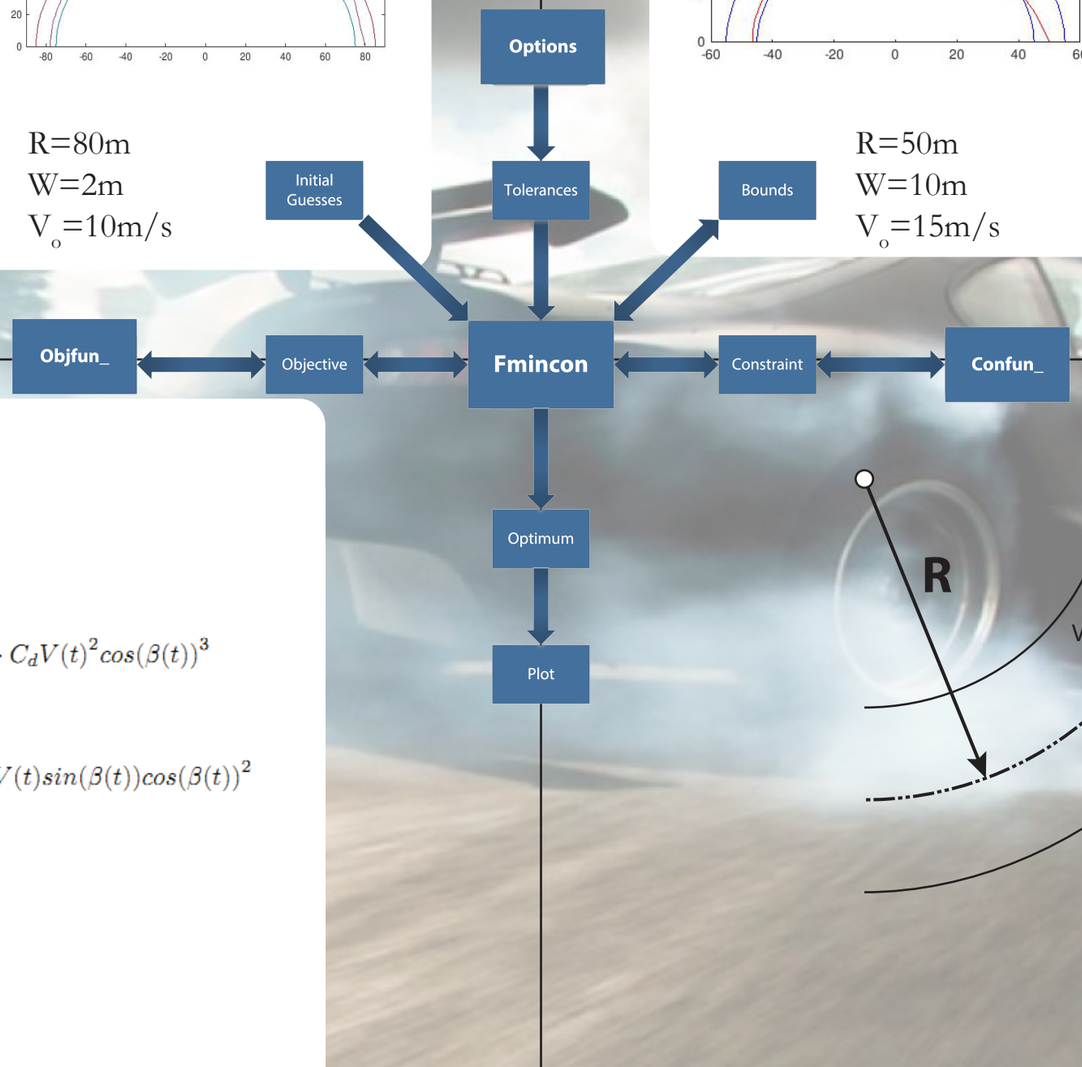
$$\dot{s_n}(t) = V(t)\, sin(\delta(t))$$
$$\dot{s_t}(t) = \frac{V(t)\, cos(\delta(t))}{1 - \frac{s_n(t)}{R}}$$
$$\dot{V}(t) = a$$

R=50m
W=10m
V_o=15m/s

Time=3.4597 s



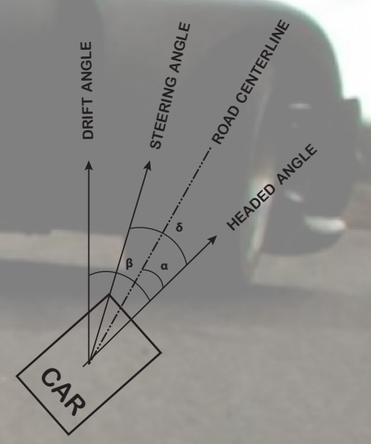
R=10m
W=10m
V_o=10m/s



MODEL 3

$$\dot{s_n}(t) = V(t)\, sin(\alpha(t) + \beta(t))$$
$$\dot{s_t}(t) = \frac{V(t)\, cos(\alpha(t) + \beta(t))}{1 - \frac{s_n(t)}{R}}$$
$$\dot{V}(t) = g\left(S(t)cos(\delta(t) - \beta(t)) - f(t)sin(\delta(t) - \beta(t))\right) - C_d V(t)^2 cos(\beta(t))^3$$
$$\dot{\omega}(t) = \frac{(\tau(t) - S(t)r)Mg}{I}$$
$$\dot{\beta}(t) = g\left(S(t)sin(\delta(t) - \beta(t)) + f(t)cos(\delta(t) - \beta(t))\right) + C_d V(t) sin(\beta(t))cos(\beta(t))^2$$
$$\dot{\alpha}(t) = -\frac{V(t)\, cos(\alpha(t) + \beta(t))}{R - s_n(t)}$$
$$S(t) = \mu_s$$
$$f(t) = \mu_f$$

DIAGRAMS



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