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第五章作业思路提示

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1. 预测模型 更新

1. 车辆动力学模型依据

$$m\dot{v} = -mur + 2\left[C_{cf}\left(\delta_f - \frac{v + ar}{\dot{x}}\right) + C_{cr}\frac{br - v}{u}\right]$$

$$m\dot{u} = mvr + 2\left[C_{lf}s_f + C_{cf}\left(\delta_f - \frac{v + ar}{u}\right)\delta_f + C_{lr}s_r\right]$$

$$I_z\dot{r} = 2\left[aC_{cf}\left(\delta_f - \frac{v + ar}{u}\right) - bC_{cr}\frac{br - v}{u}\right]$$

$$\dot{Y} = u\sin\varphi + v\cos\varphi$$

$$\dot{X} = u\cos\varphi - v\sin\varphi$$

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```
/* 全局坐标系 */
fg[1 + x_start + t] = x_1 - (x_0 + v_longitudinal_0 * CppAD::cos(psi_0) * dt - v_lateral_0 * CppAD::sin(psi_0) * dt);
fg[1 + y_start + t] = y_1 - (y_0 + v_longitudinal_0 * CppAD::sin(psi_0) * dt + v_lateral_0 * CppAD::cos(psi_0) * dt);

/* 航向角变化 */
fg[1 + psi_start + t] = psi_1 - (psi_0 - v_longitudinal_0 * (front_wheel_angle_0 / 1) / lf * dt);

/* 车辆纵向速度 */
fg[1 + v_longitudinal_start + t] = v_longitudinal_1 - (v_longitudinal_0 + longitudinal_acceleration_0 * dt);

/* 车辆侧向速度 */

AD<double> a_lateral = ((-v_longitudinal_0) * (yaw_rate_0)) +
                       (2 / m) * (Cf * ((-front_wheel_angle_0 / 1) - ((v_lateral_0 + lf * yaw_rate_0) / (v_longitudinal_0))) + Cr * ((lr * yaw_rate_0 - v_lateral_0) /
                       (v_longitudinal_0)));
fg[1 + v_lateral_start + t] = v_lateral_1 - (v_lateral_0 + a_lateral * dt);

/* 车辆横摆角速度 */
AD<double> yaw_acceleration = 2 / I * ((lf * Cf * (((-front_wheel_angle_0 / 1) - ((v_lateral_0 + lf * yaw_rate_0) / (v_longitudinal_0))))) - (lr * Cr * (lr * yaw_rate_0 -
v_lateral_0) / (v_longitudinal_0)));
fg[1 + yaw_rate_start + t] = yaw_rate_1 - (yaw_rate_0 + yaw_acceleration * dt);

/* 横向位置跟踪误差 */
fg[1 + cte_start + t] = cte_1 - (f_0 - y_0 + v_longitudinal_0 * CppAD::tan(epsi_0) * dt);

/* 航向跟踪误差 */
fg[1 + epsi_start + t] = epsi_1 - (psi_0 - psi_des_0 - v_longitudinal_0 * (front_wheel_angle_0 / 1) / Lf * dt);
```

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1. 代价函数

1. 位置跟踪能力
2. 速度跟踪能力
3. 航向跟踪能力
4. 控制信号幅值
5. 控制信号变化率

```
/* Objective term 1: Keep close to reference values.*/
for (size_t t = 0; t < N; t++)
{
    fg[0] += cte_weight * CppAD::pow(vars[cte_start + t] - ref_cte, 2);
    fg[0] += epsi_weight * CppAD::pow(vars[epsi_start + t] - ref_epsi, 2);
    fg[0] += v_weight * CppAD::pow(vars[v_start + t] - ref_v, 2);
}
/* Objective term 2: Avoid to actuate as much as possible, minimize the use of actuatos.*/
for (size_t t = 0; t < N - 1; t++)
{
    fg[0] += actuator_cost_weight * CppAD::pow(vars[delta_start + t], 2);
    fg[0] += actuator_cost_weight * CppAD::pow(vars[a_start + t], 2);
}
/* Objective term 3: Enforce actuators smoothness in change, minimize the value gap between sequential actuations.*/
for (size_t t = 0; t < N - 2; t++)
{
    fg[0] += change_steer_cost_weight * CppAD::pow(vars[delta_start + t + 1] - vars[delta_start + t], 2);
    fg[0] += change_accel_cost_weight * CppAD::pow(vars[a_start + t + 1] - vars[a_start + t], 2);
}
```

在线问答

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Q&A

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感谢各位聆听！

Thanks for Listening