SEOUL NATIONAL UNIVERSITY
DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

CONTROL SYSTEM THEORY **Fall 2010**

HW#2 **Assigned: September 27 (Mo)**
Due: October 6 (We)

Consider a path tracking system shown in the Figure 1 below:

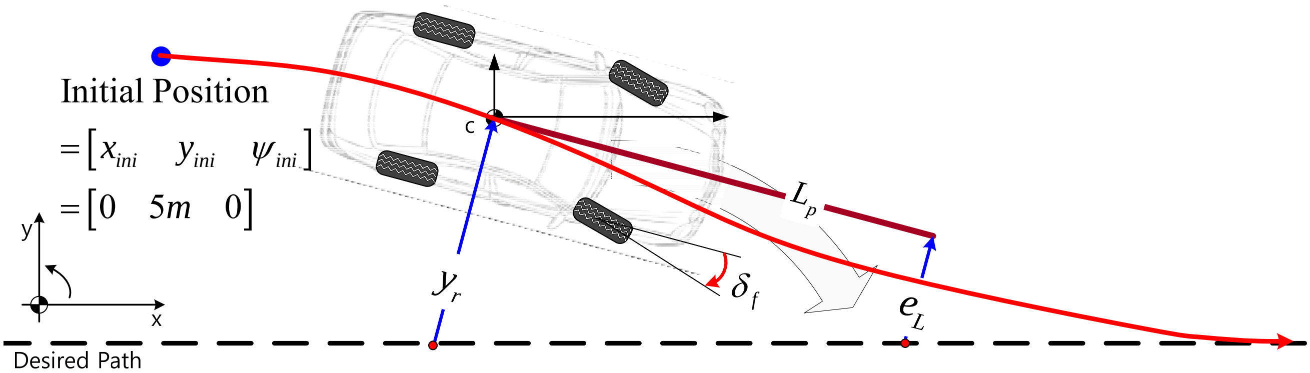

Fig.1 Path tracking system

1. Design a path tracking steering control law and evaluate the controller through numerical simulations. The vehicle simulations should be conducted under the following conditions:

- Vehicle speed is 30 km/h.
- 2 DOF bicycle model in the **HW#1** is used for vehicle model.
- Initial position of vehicle is set to be as follows: $[x_{ini} \quad y_{ini} \quad \psi_{ini}] = [0 \quad 5m \quad 0]$
- Desired path is straight road as shown in Fig.1

(1) Plot lateral position error (y_r) and preview distance error (e_L) when preview distance (L_p) is set to be 5m, 10m and 15m.

(2) Plot the front steering angle for lane keeping. (L_p = 5, 10 and 15m)

(3) Plot body slip angle and yaw rate. (L_p = 5, 10 and 15m)

(4) Plot vehicle trajectory. (L_p = 5, 10 and 15m)

(5) Discuss on the control performance and the vehicle behaviors for same control gains at different preview distances.

[Tip for a lane keeping or path tracking system]

A lane keeping system for numerical simulation consists of three parts: a vehicle model, a lane keeping controller and a tacking error calculator as shown in Fig.2.

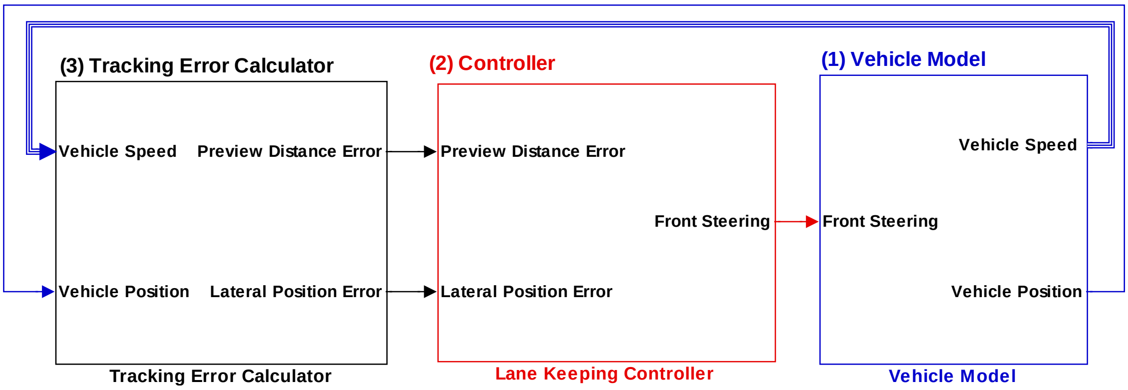

Fig.2 Lane Keeping Model

1) Vehicle Model

▪ 2 DOF bicycle model in the **HW#1** is used for vehicle model.

2) Lane Keeping Controller

▪ A lane keeping controller is designed to determine a front steering angle using the lateral position error (y_r) and the preview distance error (e_L). The front steering angle can be determined as follows:

$$\delta_f = -k_1 \cdot y_r \quad -k_2 \cdot e_L \qquad \text{where, } k_1 \text{ and } k_2 \text{ are control gains}$$

3) Tracking Error Calculator

▪ When a desired path is a straight road ($\psi_d = 0$), the tracking error can be calculated as shown in Fig.3.

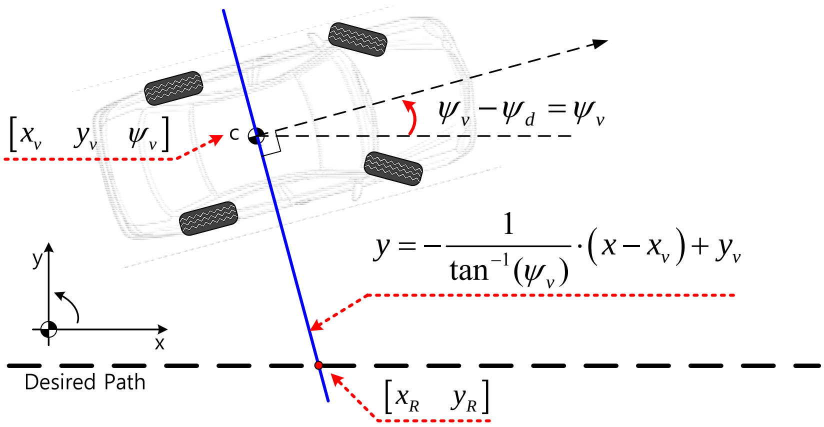

Fig.3 Tracking Error Calculator

▪ Reference Road Position

$$[x_R \quad y_R] = [x_v + \tan^{-1}(\psi_v) \cdot y_v \quad 0]$$

▪ Lateral Position Error

$$y_r = \begin{cases} \sqrt{(x_v - x_R)^2 + (y_v - y_R)^2} & if\,(y_v \geq 0) \\ -\sqrt{(x_v - x_R)^2 + (y_v - y_R)^2} & elsewhere \end{cases}$$

▪ The preview distance error can be calculated similarly to the lateral position error.