Obstacle Avoidance Constraint in Lateral Controller

I think following function can be easily incorporated to the current lateral MPC controller in order to provide collision avoidance capability. Let $x(t)$ and τ be a vehicle position at time t and a obstacle position, respectively. Two variables α and s are tuning parameters. The scalar value w is a weight parameter.

$$z(t) = w\frac{\exp(-\alpha(\|x(t) - \tau\|^2 - s^2))}{1 + \exp(-\alpha(\|x(t) - \tau\|^2 - s^2))} \tag{1}$$

$z(t)$ applies large penalty to the position of the obstacle that is located at τ. Therefore, this term can be added in the cost function. Alternatively, we can use this term as a hard constraint, *i.e.* $z(t) \leq \bar{z}$, where $\bar{z}$ is minimum allowed distance to the obstacle.

Fig.1 and Fig.2 shows the effect of two tuning parameters s and α. horizontal axis is x, vertical axis is z for both Fig.1 and 2. As shown in Fig.1 the parameter s determines the range of penalty effect.

As shown in Fig.2 the parameter α determines growing rate of the penalty.

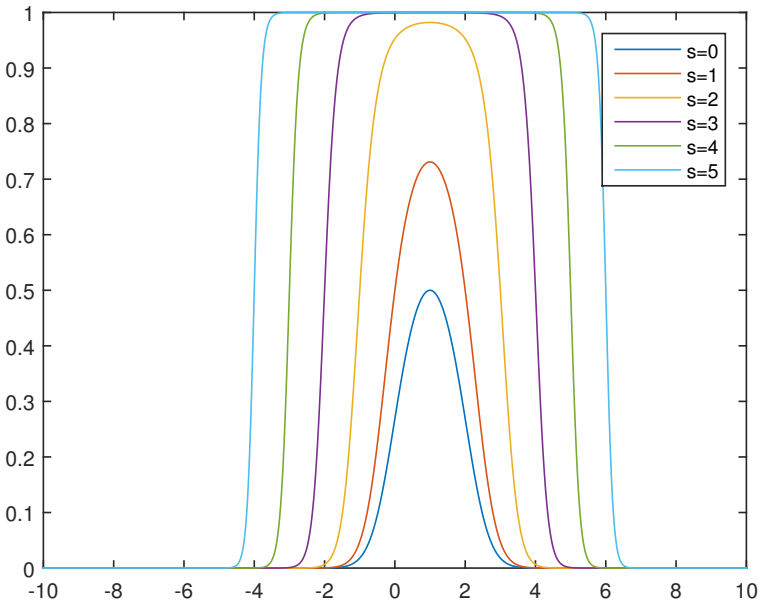

Figure 1: Obstacle penalty term parametrized by s.

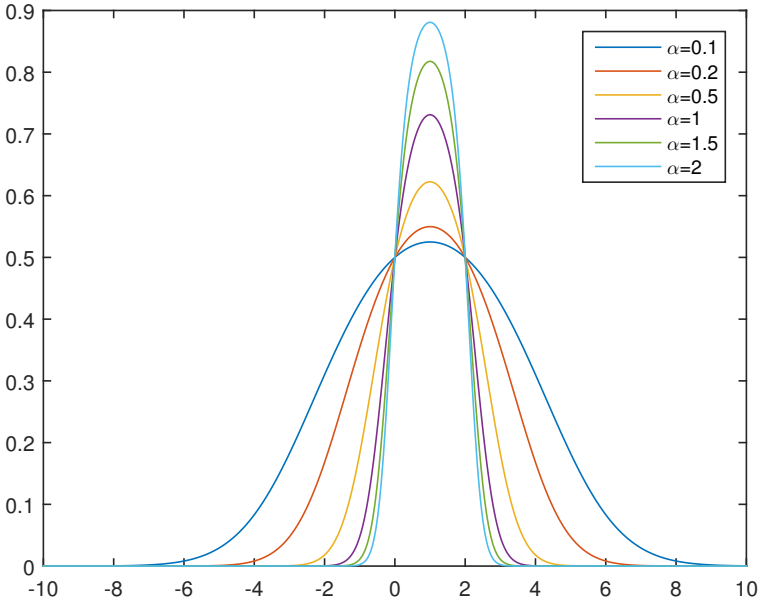

Figure 2: Obstacle penalty term parametrized by α.