Abstract—This project focused on issues of trajectory planning and motion control of autonomous vehicles. First, a method based on a fifth-order polynomial is adopted for the path planning. Its major advantages are unique solution under a specified initial condition, simple algorithm and thus fast computation. Next, by taking into account the unavailability of the system nonlinearities and the chained structure of the vehicle dynamics, the multi-switching adaptive neural control is adopted for the motion control. In particular, the proposed design is global and hence is more appealing to practical applications.

Path Planning
The path planning for the cart is given by
\[
\begin{align*}
    x(t) &= A_x t^5 + B_x t^4 + C_x t^3 + D_x t^2 + E_x t + F_x \\
    y(t) &= A_y t^5 + B_y t^4 + C_y t^3 + D_y t^2 + E_y t + F_y \\
    \theta(t) &= A_\theta t^5 + B_\theta t^4 + C_\theta t^3 + D_\theta t^2 + E_\theta t + F_\theta
\end{align*}
\]

\[\text{Figure 1. The coordinate system of an autonomous cart.}\]

\[\text{Figure 2. The planned position, velocity, and the acceleration trajectories.}\]

Control Design

A. Fuzzy Logic Systems
The output of the FLS, assuming the singleton fuzzifier, product inference, center-average defuzzifier, and Gaussian membership function are adopted, can be expressed as follows
\[
y = \frac{\sum_{i=1}^{n} \mu_{A_i}(x_i)}{\sum_{i=1}^{n} \mu_{A_i}(x_i)} = \Theta^T \phi(x)
\]

B. Dynamic control Design
The FLC is adopted for approximating \( H(v, \dot{v}) \) as follows
\[
H(v, \dot{v}) = \Theta^T \phi + \epsilon,
\]

The control law for the motor torque vector is assigned as
\[
\tau = B^{-1}[-k_v v + \tilde{\Theta}^T \phi - \bar{e} \cdot \text{sgn}(v_e)]
\]

The update algorithm for \( \tilde{\Theta} \) is given by
\[
\dot{\tilde{\Theta}} = -\sigma \phi v_e^T
\]

Experimental Results

\[\text{Figure 3. The experimental platform.}\]

\[\text{Figure 4. Tracking errors.}\]

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References