An Enhanced Sliding Mode Control for Wheeled Mobile Robot Trajectory Tracking

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Abstract—In this paper, an approach of trajectory tracking control combined Lyapunov based and sliding mode control for wheeled mobile robot has proposed. The convergence efficiency of errors in this method is much better than the original, and the chattering problem on the control value can also be solved. Therefore, mobile robots can track trajectories smoothly and quickly. Finally, the simulation result shows the performance of proposed control.

I. INTRODUCTION

With industrial demand, mobile robot has become an important part in production line and serving. Some controller for mobile robot, such as feedback linearization, backstepping[1], neural networks and fuzzy control, fuzzy logic control or sliding mode control[2], have been studied, and the tracking errors can guaranteed to zero in most controller by Lyapunov theory. To improve the convergence efficiency, a new controller combined sliding mode control and Lyapunov based control has proposed in this paper.

II. KINEMATIC MODEL OF WHEELED MOBILE ROBOT

The parameters of WMR has shown in Fig. 1. The center location of mobile robot is defined as \( P = [x, y, \theta]^T \), where \([x, y]\) is the position of robot center, and \( \theta \) denotes the robot orientation angle. Assume there is no slip happened on wheels, then the kinematic is given as

\[
\dot{P} = [\dot{x}, \dot{y}, \dot{\theta}]^T = [v \cos \theta, v \sin \theta, \omega]^T
\]  

where \( v \) and \( \omega \) represent the translational and angular velocities, respectively. Then, the differential of errors can be obtained as

\[
[x_e, y_e, \theta_e] = [v_e \cos \theta_e - v + \omega_e \theta_e, v_e \sin \theta_e - \omega_e \omega_e, \omega_e - \omega]
\]  

Fig.1. the configuration of wheeled mobile robot

III. CONTROLLER DESIGN

A famous Lyapunov-based controller for WMR is given as follows:

\[
v = v_e \cos \theta_e + k_{x} x_e
\]

\[
\omega = \omega_e + k_{y} v_e \sin \theta_e \sin \theta_e + k_{\theta} \theta_e
\]  

Another controller from [3] is given as

\[
v = \omega_e + k_{x} y_e + v_e \sin \theta_e + \omega_e + k_{\theta} \theta_e
\]

\[
\omega = \omega_e + k \text{sgn}(s)
\]

The two controller can be combined together as

\[
v = \omega_e + k_{x} y_e + v_e \sin \theta_e + \omega_e + k_{\theta} \theta_e
\]

\[
\omega = \omega_e + k \text{sat}(s) + k_{y} v_e \sin \theta_e \sin \theta_e + k_{\theta} \theta_e
\]

IV. SIMULATION RESULTS

V. CONCLUSION

A controller based on Lyapunov theory and sliding mode control has proposed. Simulation result shows that the convergence efficiency of combined controller is better than the two original controllers, and the chattering problem can be solve by using sat instead of sign function

REFERENCES