Shared Path Following Control of Intelligent Surface Vehicles with Course Keeping and Collision Avoidance

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***Abstract*—Cooperative steering of the human driver and automated system can effectively reduce the necessity of extremely accurate environment perception of intelligent surface vehicles (ISVs), and enhance the safety and fault-tolerance of decision-making and motion control. This paper presents a way-point line-of-sight (LOS) path following method of underactuated ISVs based on shared L1 adaptive control in complex ship course with dynamic and static obstacles. At the kinematics level, a way-point LOS guidance law is presented. The proposed guidance law maintains ISVs navigation within the ship's course. At the kinetic level, an predictor is developed to estimate model uncertainties and environmental disturbances, and a shared L1 adaptive kinetic control is constructed based on the predictor and Lyapunov-like control barrier function. The Lyapunov-like control barrier function is developed to collision avoidance and aid the human driver when necessary. Meanwhile, the designed shared weighted coefficient is introduced creatively for assessing the ISV's safety status in which error of the yaw angle and the relative distance between the ISV and the obstacle are taken into consideration. The proposed kinetic control method not only enhance the tracking accuracy and stability, but also enables the ISVs to combine the complementary strengths of the human driver and the automated system. By using the input-to-state stability theory, uniformly and ultimately bounded of the closed-loop system is analyzed. The simulation results are provided to validate the effectiveness of the proposed method.**

***Index Terms*—way-point LOS guidance; shared L1 adaptive control, path following, intelligent surface vehicle**

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