17th International Conference on Innovative Computing, Information and Control (ICICIC2023)
Kumamoto, Japan, August 29-31, 2023

Paper ID: ICICIC2023-SS26-07

Underactuated AUV Trajectory Tracking Control for Speed Sensor Failure

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Introduction

In recent years, as human beings continue to explore the ocean and discover that the ocean is a huge treasure of resources and energy, people have gradually turned their attention to the study of marine equipment. Unmanned marine equipment has a variety of advantages, and is currently the key research content and development object of marine equipment technology. Autonomous underwater vehicle (AUV) trajectory tracking is a key research area at present.

Research Questions

This paper focuses on the trajectory tracking control problem of a class of underdriven five-degree-of-freedom UUVs with velocity sensor failure.

Methodologies

In order to decompose the model into drivable and non-drivable parts, the UUV output points are redefined, the speed of the UUV is estimated based on the state observer, and a double closed-loop integral sliding mode is used to control it to ensure that the underdriven UUV is tracking the moving target.

Mathematical Formulas

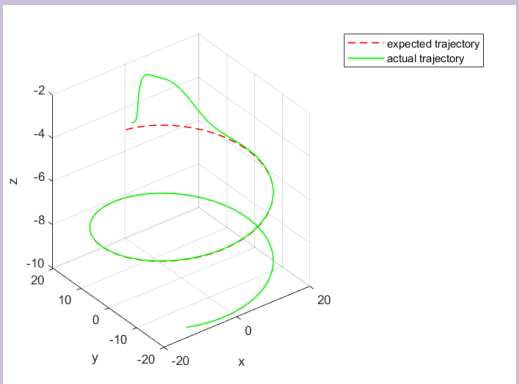
$$\dot{r} = J_r(\xi)v$$

$$M\dot{v} = -C(v)v - D(v)v - g(\xi) + \tau$$

$$s_h = e_h + k_h \int_0^t e_h(t)dt$$

$$V = \frac{1}{2} s_h{}^T s_h + \frac{1}{2} s_{\hat{v}}{}^T M_1 s_{\hat{v}} + V(\tilde{r}, \tilde{v})$$

Figure



Conclusion

This paper introduces the model of the control object and some transformations of the model; after that, this paper shows in detail the state observer used in this section and completes the stability theory proof by Lyapunov stability theory; secondly, this paper designs the speed controller with double closed-loop structure by using the speed estimation value, and gives the trajectory tracking controller for the underdriven UUV with the failure of the speed sensor; subsequently, this paper designs the suitable Lyapunov function and proves the stability of the controller using Lyapunov stability theory. At the end of the chapter, this paper uses simulation experiments to track the trajectory of the spiral dive, and the simulation results illustrate that the adopted state observer can well estimate the speed of the underdriven UUV, the designed UUV controller has good control effect, and it can accomplish the 3D trajectory tracking task under the failure of the speed sensor.