*Journal of Zhejiang University-SCIENCE A*

# Three-degree-of-freedom motion posture stabilization control of platform based on DTW-LSTM-MATD3 under high and low frequency disturbances of ships

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Cite this as: Qin ZHANG, Jingyi ZHOU, Bangping GU, Xiong HU, 2026. Three-degree-of-freedom motion posture stabilization control of platform based on DTW-LSTM-MATD3 under high and low frequency disturbances of ships. *Journal of Zhejiang University-SCIENCE A*, 27(3):246-261.
https://doi.org/10.1631/jzus.A2500146

# Classification of Control Strategies

Control methods

**Traditional control method based on model**

- **proportional-integral-derivative (PID)**
- **model predictive control (MPC)**
- **linear quadratic gulator (LQR)**

…

**reinforcement learning algorithms**

- **proximal policy optimization (PPO)**
- **multi-agent deep deterministic policy gradient (MADDPG)**
- **multi-agent soft actor-critic (MASAC)**
- **multi-agent twin delayed deep deterministic policy gradient (MATD3)**

…

# Ship 3-DoF motion compensation system model

## ■ Kinematic analysis and dynamic model

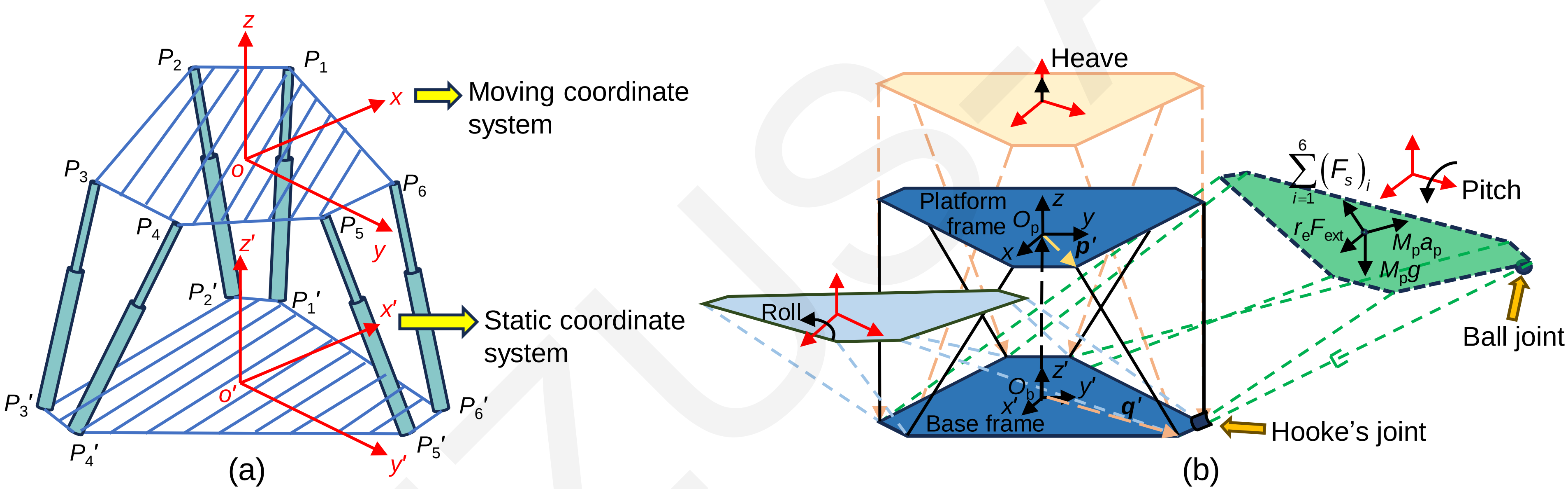


**Fig. 1. Coordinate system of the parallel 3-DoF platform mechanism of the ship motion compensation system: (a) coordinate system of the parallel six-degree-of-freedom mechanism; (b) simulation of the motion of each electric cylinder of the Stewart platform under different force conditions**

# Ship 3-DoF compensation control method based on DTW-LSTM-MATD3

**Inverse solution** → **DTW analysis** → **Training of RL agent**

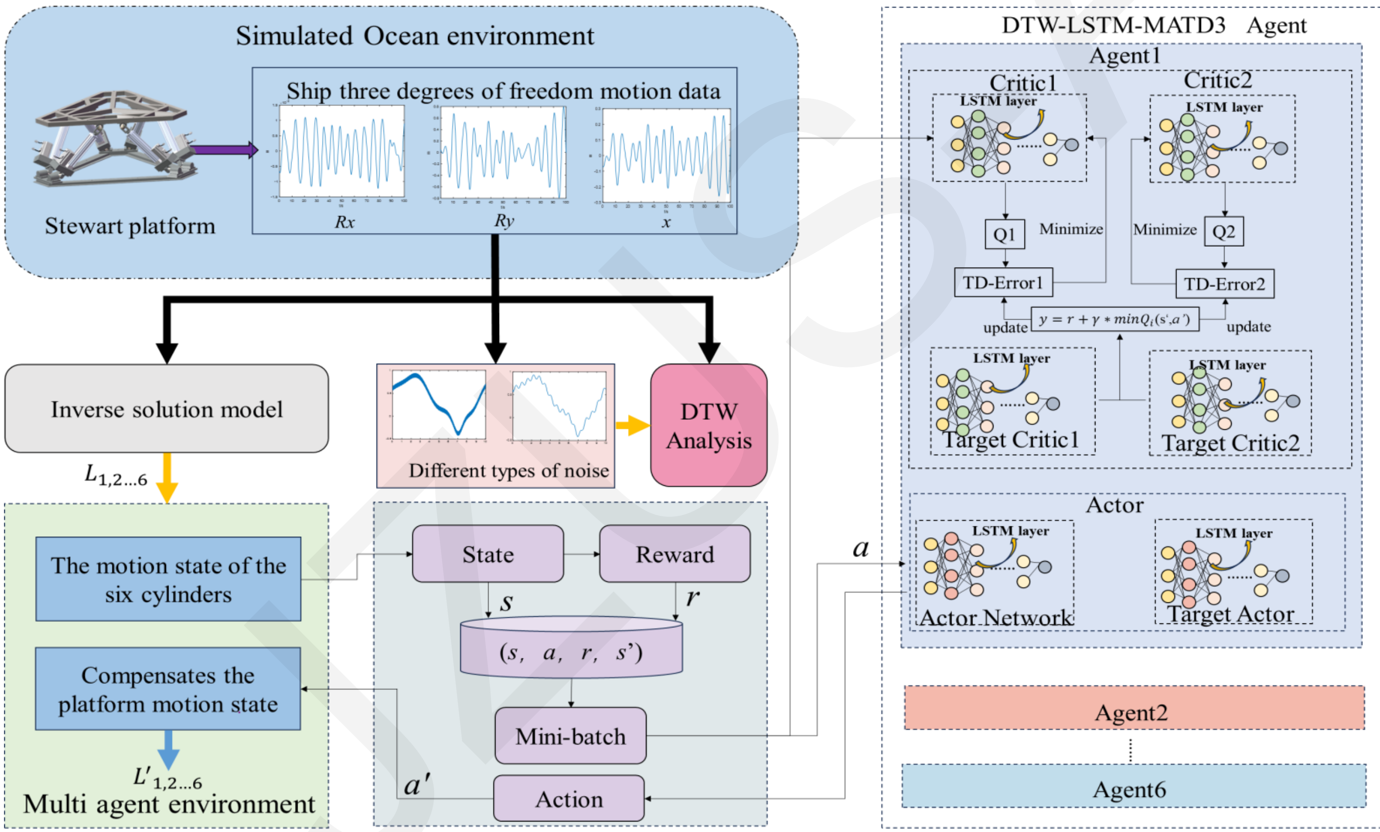


**Fig. 2 Structure diagram of the DTW-LSTM-MATD3 algorithm**

# Compensation control experiment under sixth-level sea and sudden change sea conditions

## ■ Tests involving high-frequency noise

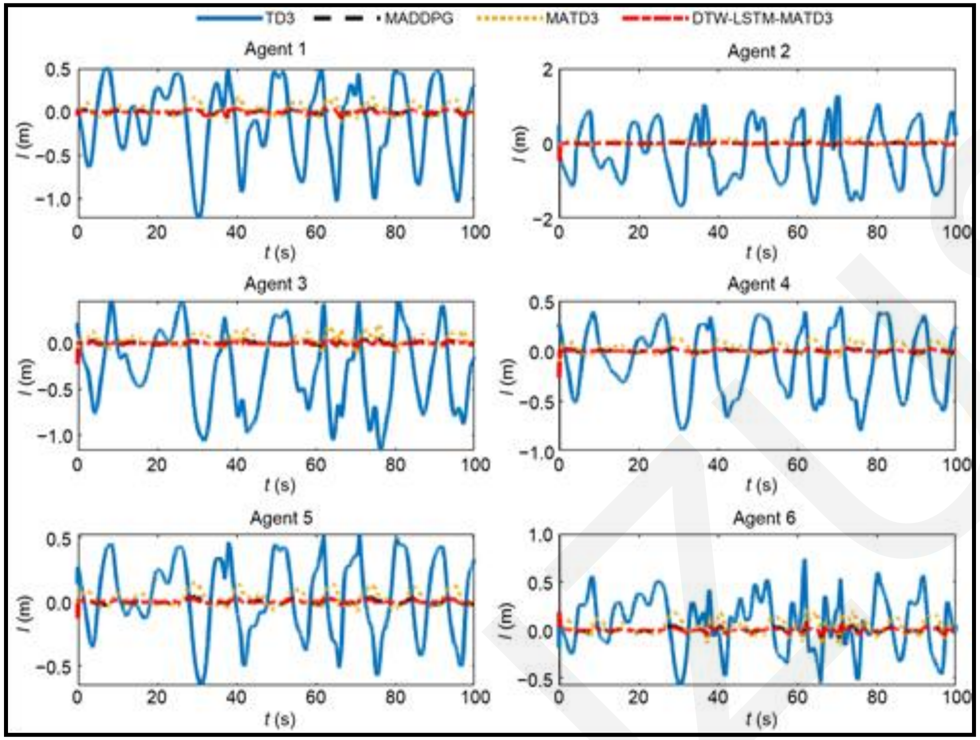


Fig. 3 Compensation control error of each algorithm under sixth-level sea conditions

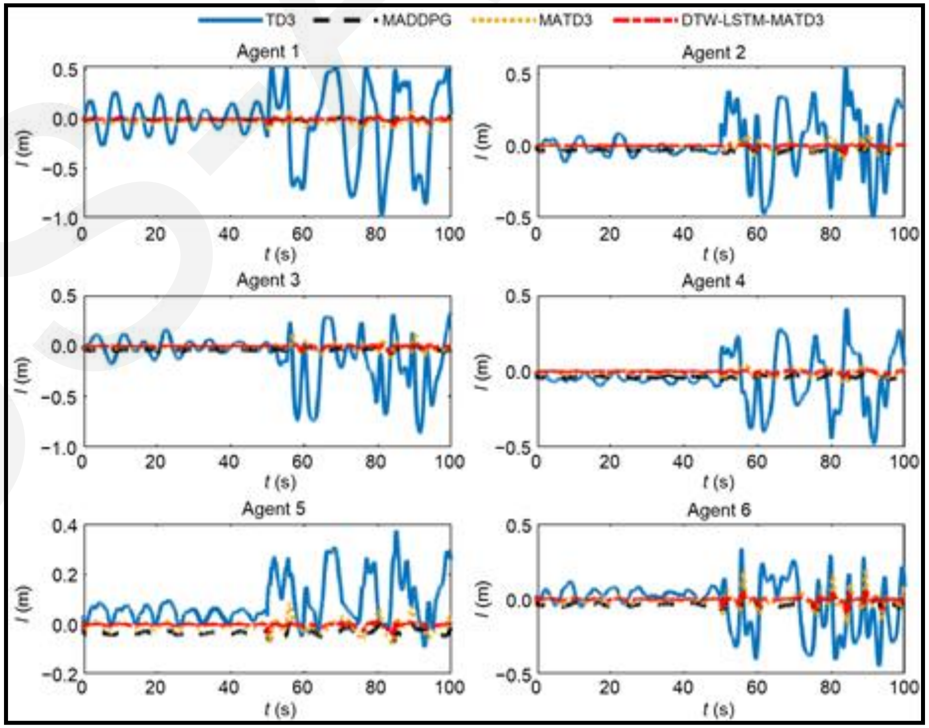


Fig. 4 Compensation control error of each algorithm under sudden change from fourth to sixth-level sea conditions

# Compensation control experiment under real sea conditions

## ■ Tests involving noise and sudden sea conditions

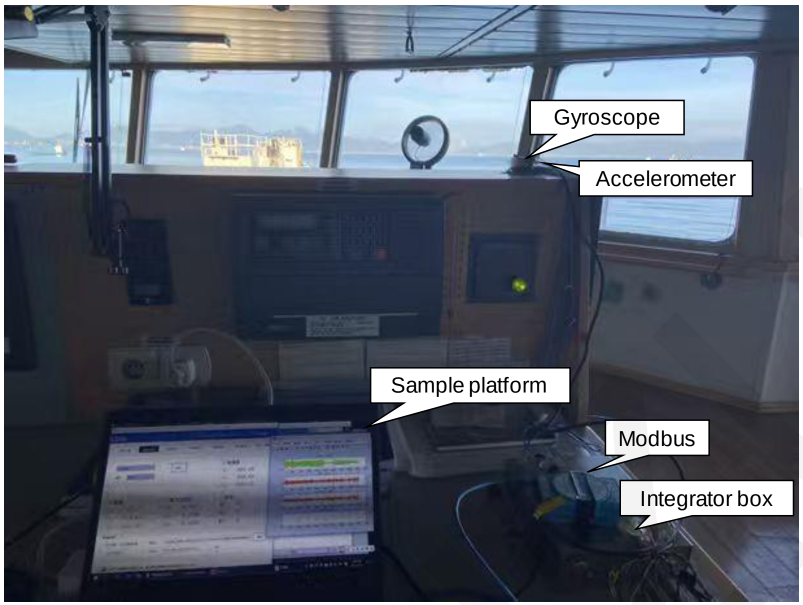


**Fig. 5 On-site diagram of the ‘Yuming’ ship’s motion attitude test**

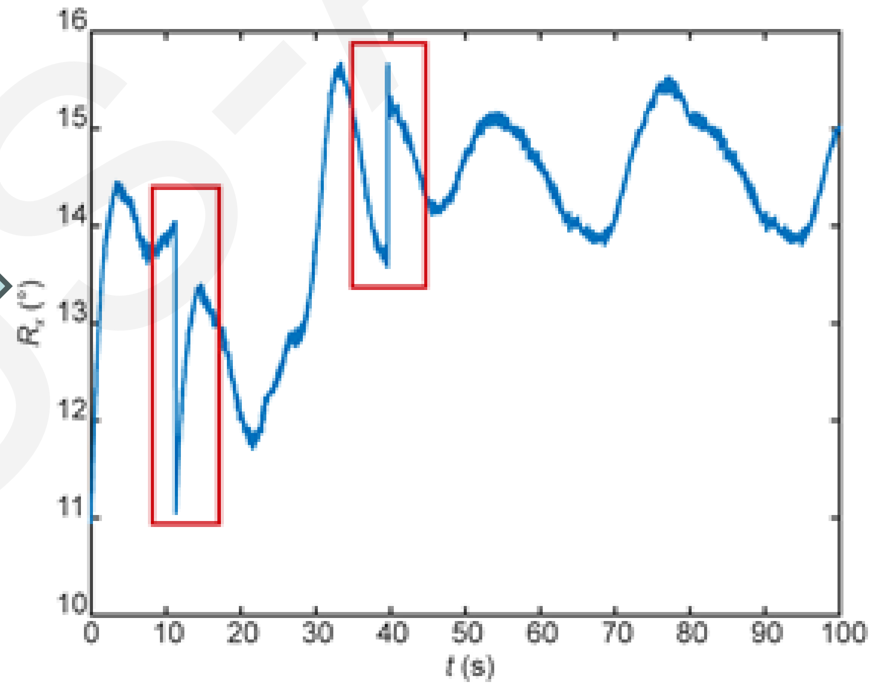


**Fig. 6 Roll motion diagram of the ‘Yuming’ ship under sudden changes in sea conditions with real noise**

# Conclusions

- **The DTW algorithm can determine the boundary point between high-frequency and low-frequency noise signals, enabling the compensation system to achieve high-frequency noise resistance and track low-frequency signal movements.**

- **The MATD3 algorithm employs an LSTM neural network and a composite reward function, which can enhance the agent's training effectiveness and decision-making capabilities.**

- **Using the designed method can improve the generalization and compensation efficiency of the ship's three-degree-of-freedom compensation.**