附件 2-1　E-NNOVATE 2025 波兰国际创新展览会线上展

发明项目展板英文图片内容(一)

CAI No.04-1

Invention: A prediction method and device for offshore platform motions based on CEEMDAN-Transformer

基于 CEEMDAN-Transformer 的海上平台运动响应预报方法及装置

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Patent No.: 2024118570268

Introduction：

(1) Advantages and significance of the invention:

The proposed CEEMDAN-Transformer architecture addresses nonlinear motion prediction of offshore platforms by combining signal decomposition and attention mechanisms. It achieves an RMSE of 0.1647, with 34% higher accuracy than LSTM, enabling real-time safety guidance.

Adaptive noise injection and extreme-value-based stopping improve decomposition stability, optimize scheduling, and cut maintenance costs by over 20%. It enhances offshore safety and reduces engineering risks.

The method also applies to other marine structures and, when paired with digital twins and edge computing, supports intelligent deep-sea operations.

(2) Applications

The CEEMDAN-Transformer architecture is applied in real-time motion prediction and safety monitoring systems for offshore platforms. This supports timely decision-making for operational adjustments, emergency responses, and maintenance scheduling, reducing engineering risks and maintenance costs. The method can also be extended to other marine structures, such as Floating Production Storage and Offloading (FPSO) vessels and offshore wind turbines, to enhance their operational safety and efficiency. For FPSO vessels, which are frequently used in deep-sea oil and gas production, the CEEMDAN-Transformer architecture can predict complex nonlinear motions caused by waves, wind, and currents, thereby improving the accuracy of cargo transfer, drilling operations, and mooring system control. In the case of offshore wind turbines, the model can forecast tower and blade vibrations due to environmental loads, supporting predictive maintenance and reducing downtime and structural fatigue. Furthermore, when integrated with digital twin systems and edge computing, the architecture enables real-time simulation and monitoring of these structures.

(3) Research achievements

The achievements include one published academic monograph, over 55 research papers, 10 authorized invention patents, and 4 registered software copyrights.

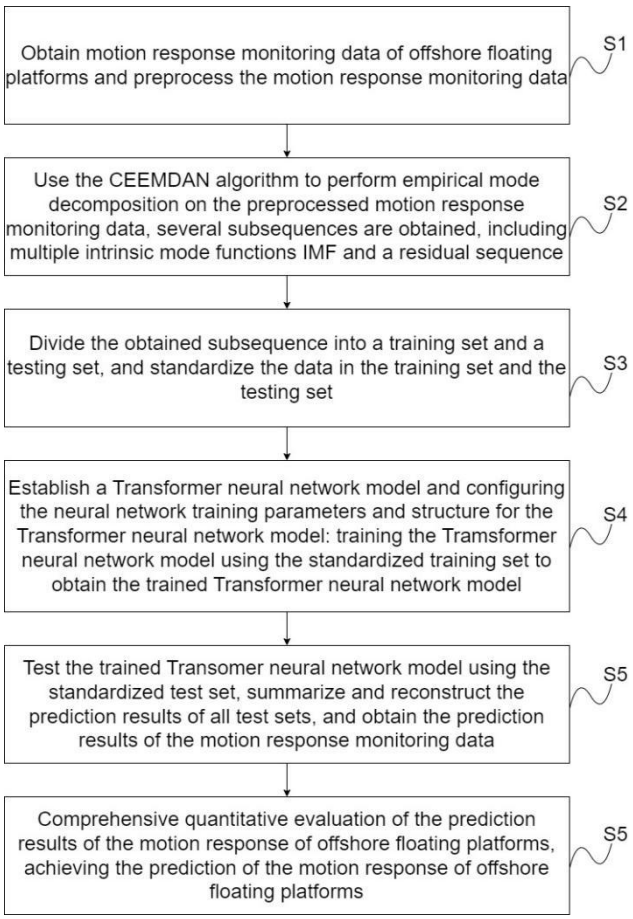


Fig. 1 Flow chart

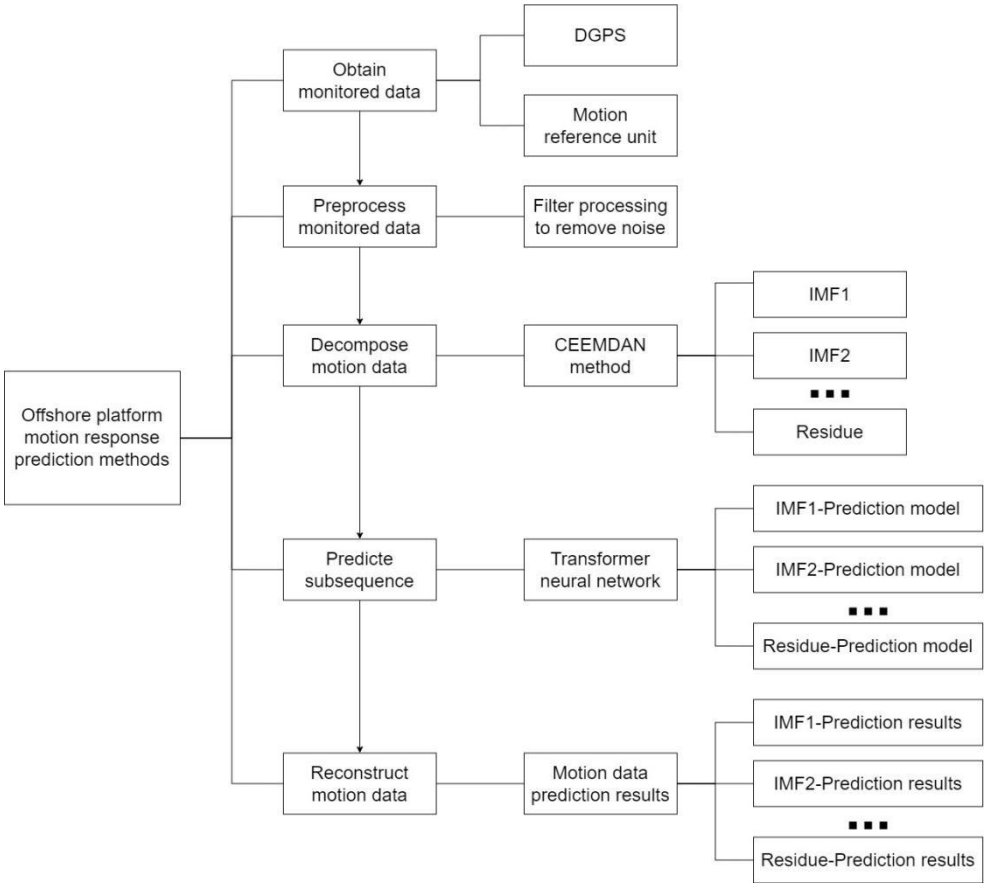


Fig. 2 Algorithm structure

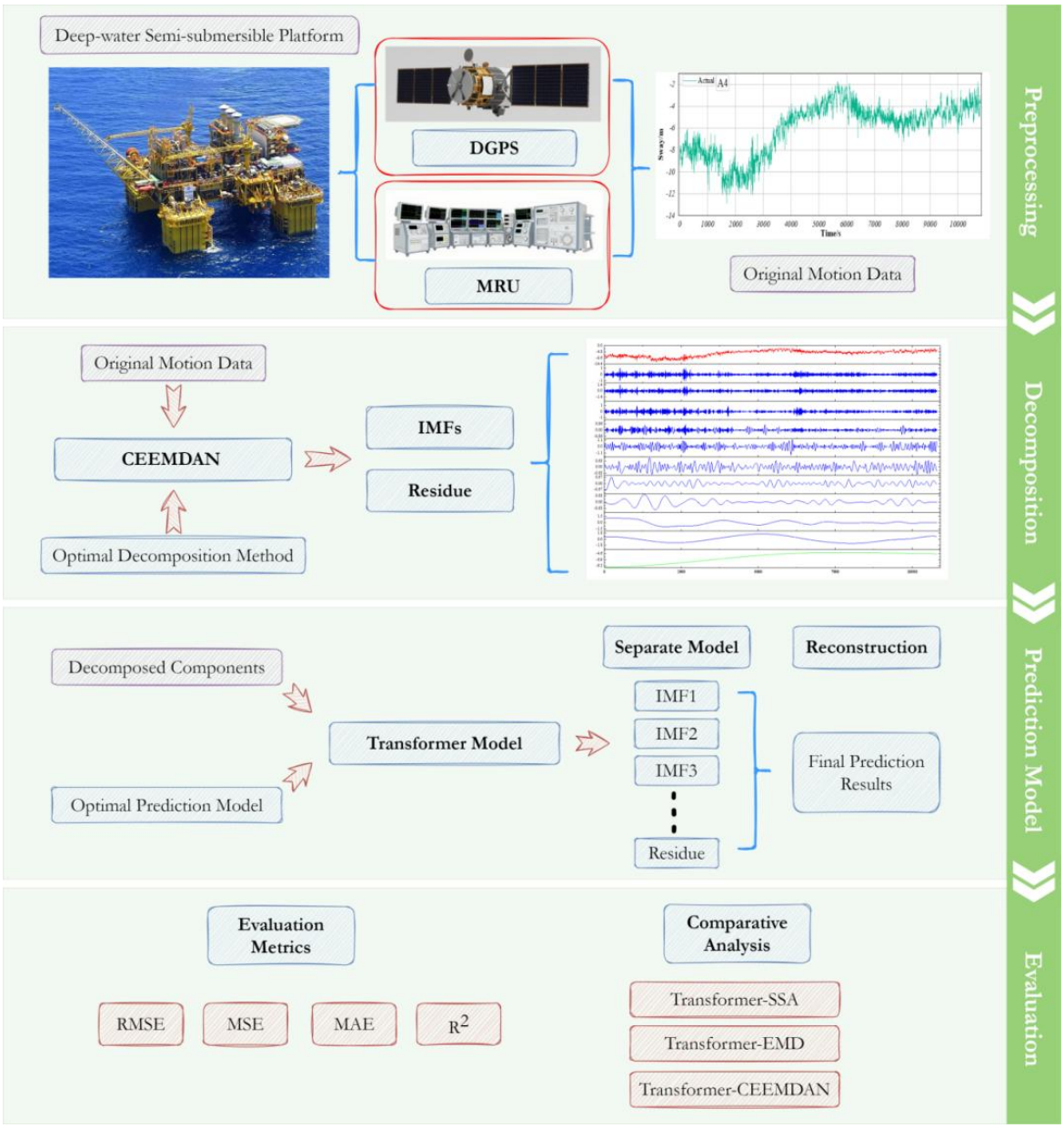


Fig. 3 Topological diagram

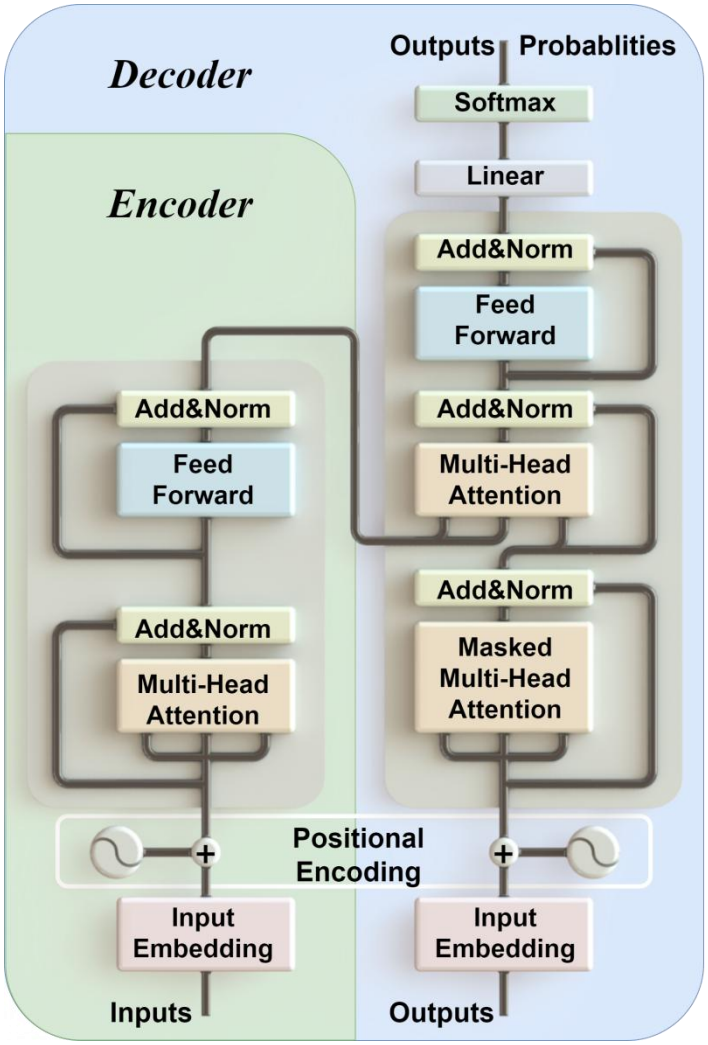
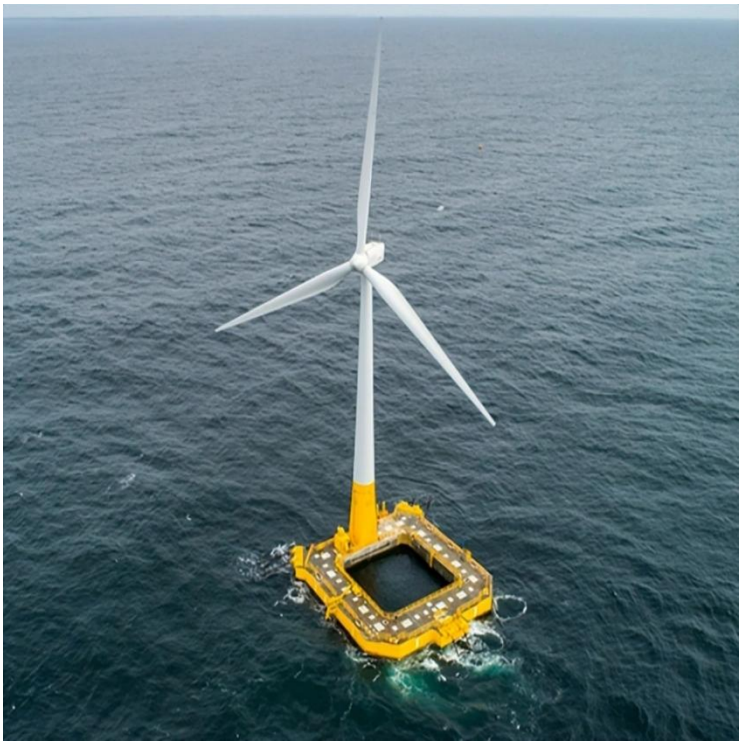


Fig. 4 Structure of the Transformer model

Fig. 5 Research achievements

(a) Prediction of heave motion for semi-submersible platforms: semi-submersible platforms are semi-submerged floating structures commonly used in offshore oil and gas exploration, marine construction, and scientific research. Accurate prediction of this motion is crucial for ensuring safe and smooth operations in dynamic sea conditions.

(b) Prediction of heave motion for FPSOs: FPSOs (Floating Production Storage and Offloading) are large, semi-submerged ships used for processing, storing, and offloading hydrocarbons from subsea wells. Due to floating nature, FPSO are highly susceptible to heave motion, which are the vertical oscillation caused by wave action. Accurate prediction of this motion is essential for ensuring operational safety, equipment integrity, and smooth production processes.



(c) Prediction of surge motion for FOWTs: FOWTs (loating offshore wind turbines) are typically mounted on semi-submersible platforms, spar buoys, or tension leg platforms (TLPs), which are subject to six degrees of freedom (DOF) motion in waves and currents. Among these, surge motion is particularly important because that it influences the alignment between the turbine and the wind direction.

(d) Prediction of heave motion for cylindrical FPSOs: Due to large volume and complex interaction with waves, cylindrical FPSOs experience significant vertical oscillations (heave), especially in storm conditions. Accurate prediction of heave motion is essential for ensuring safe and efficient offloading of hydrocarbons and reducing fatigue on mooring systems and risers.

(e) Prediction of roll motion for cruise ships: excessive roll can lead to passenger discomfort, increased risk of injury, cargo movement, and reduced operational efficiency. Therefore, accurate and real-time roll prediction is critical for motion control systems, route optimization, and passenger safety.

Fig. 6 Application scenes

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附件 2-2　E-NNOVATE 2025 波兰国际创新展览会线上展

单位/公司介绍展板英文、图片内容（二）

CAI No.04-2

Tianjin University

Introduction：

Tianjin University (TJU), founded on October 2, 1895, as Peiyang University, is China's first modern university and a pioneer of modern Chinese higher education (Fig. 1).

TJU achieved the following rankings (Fig. 2):

- QS World University Rankings 2024: 269th (11th in China);
- Times Higher Education (THE) World University Rankings 2025: 201- 250th (16th in China);
- Best Chinese Universities Ranking 2024: 20th;
- Chinese University Engineering Strength Rating 2024: 10th.

TJU has 15 disciplines ranked in the top 1% of the Essential Science Indicators (ESI) database, including 5 in the top 1‰ and 2 (Engineering and Chemistry) in the top 0.1‰.

This invention is developed based on national research platforms at Tianjin University, including the National Facility for Earthquake Engineering Simulation and the State Key Laboratory of Hydraulic Engineering Intelligent Construction and Operation (Fig. 3).

The school adheres to the principle of opening up to the world and deepening international exchanges and cooperation in an all-round way. TJU has cooperated with 260 universities, research institutes, and companies in 50 countries and regions (Fig. 4).

For a long time, through the unremitting efforts of all teachers and students, Tianjin University has become a high-level research university with strong faculty, distinctive discipline characteristics, first-class education quality, and scientific research level in China, and a significant influence in the world.

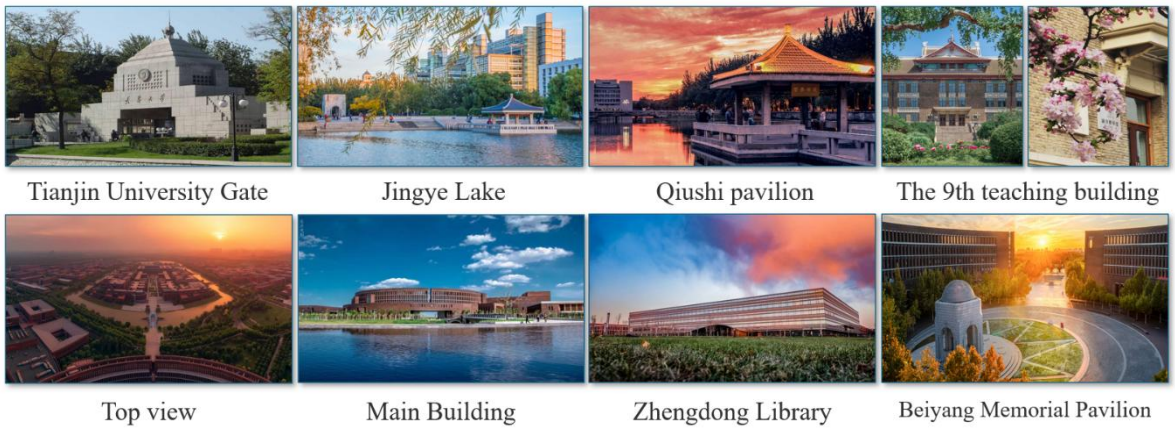

Fig. 1 Campus scenery

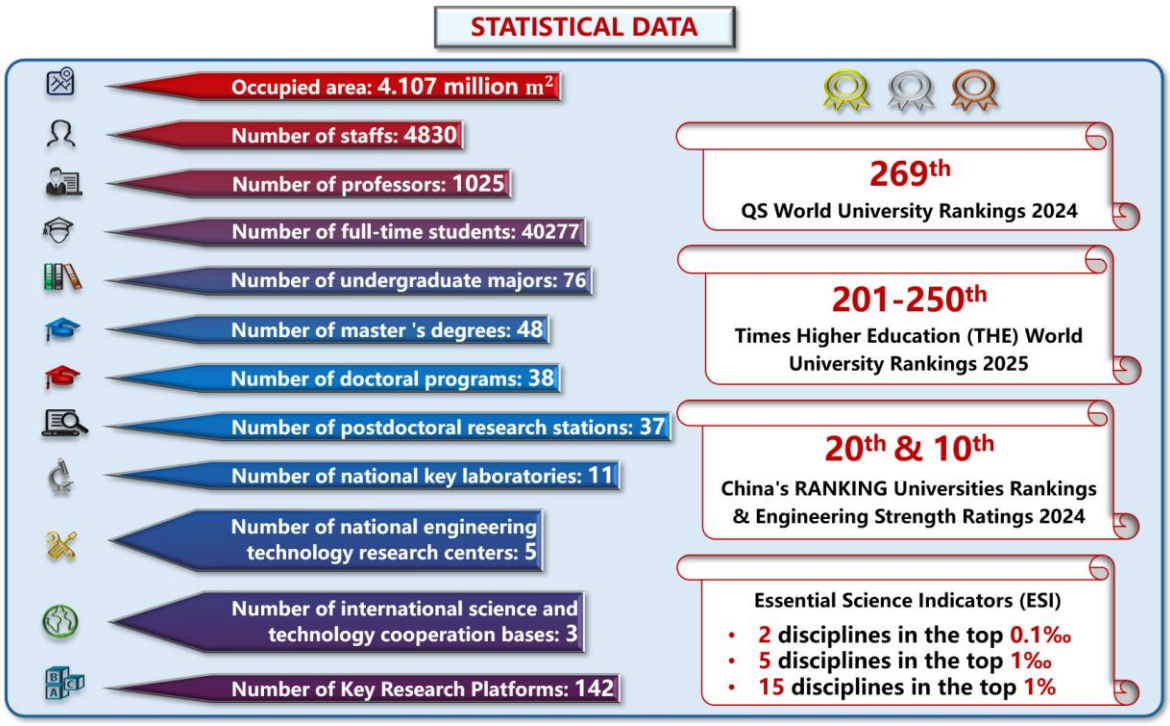

Fig. 2 Statistical data

National Facility for Earthquake Engineering Simulation

State key laboratories

Fig. 3 Scientific research platforms

Fig. 4 International certification

Fig. 5 Team photo of Naval Architecture and Ocean Engineering Speciality

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