# Novelty Assessment Report

**Paper**: Unveiling the Mechanism of Continuous Representation Full-Waveform Inversion: A Wave Based Neural Tangent Kernel Framework

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**Venue**: ICLR 2026 Conference Submission

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## Abstract

Full-waveform inversion (FWI) estimates physical parameters in the wave equation from limited measurements and has been widely applied in geophysical exploration, medical imaging, and non-destructive testing. Conventional FWI methods are limited by their notorious sensitivity to the accuracy of the initial models. Recent progress in continuous representation FWI (CR-FWI) demonstrates that representing parameter models with a coordinate-based neural network, such as implicit neural representation (INR), can mitigate the dependence on initial models. However, its underlying mechanism remains unclear, and INR-based FWI shows slower high-frequency convergence. In this work, we investigate the general CR-FWI framework and develop a unified theoretical understanding by extending the neural tangent kernel (NTK) for FWI to establish a wave-based NTK framework. Unlike standard NTK, our analysis reveals that wave-based NTK is not constant, both at initialization and during training, due to the inherent nonlinearity of FWI. We further show that the eigenvalue decay behavior of the wave-based NTK can explain why CR-FWI alleviates the dependency on initial models and shows slower high-frequency convergence. Building on these insights, we propose several CR-FWI methods with tailored eigenvalue decay properties for FWI, including a novel hybrid representation combining INR and multi-resolution grid (termed IG-FWI) that achieves a more balanced trade-off between robustness and high-frequency convergence rate. Applications in geophysical exploration on Marmousi, 2D SEG/EAGE Salt and Overthrust, 2004 BP model, and the more realistic 2014 Chevron models show the superior performance of our proposed methods compared to conventional FWI and existing INR-based FWI methods.

**Disclaimer**

This report is **AI-GENERATED** using Large Language Models and WisPaper (a scholar search engine). It analyzes academic papers' tasks and contributions against retrieved prior work. While this system identifies **POTENTIAL** overlaps and novel directions, **ITS COVERAGE IS NOT EXHAUSTIVE AND JUDGMENTS ARE APPROXIMATE**. These results are intended to assist human reviewers and **SHOULD NOT** be relied upon as a definitive verdict on novelty.

Note that some papers exist in multiple, slightly different versions (e.g., with different titles or URLs). The system may retrieve several versions of the same underlying work. The current automated pipeline does not reliably align or distinguish these cases, so human reviewers will need to disambiguate them manually.

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## Core Task Landscape

This paper addresses: **Estimating Subsurface Physical Parameters from Seismic Waveform Measurements**

A total of **50 papers** were analyzed and organized into a taxonomy with **14 categories**.

### Taxonomy Overview

The research landscape has been organized into the following main categories:

- **Full-Waveform Inversion Methods**
- **Seismic Amplitude Inversion and Rock Physics Integration**
- **Supervised Deep Learning for Inversion**
- **Semi-Supervised and Unsupervised Learning Approaches**
- **Surface-Wave and Site Characterization Methods**
- **Specialized Inversion Applications and Contexts**
- **Methodological Foundations and Auxiliary Techniques**

### Complete Taxonomy Tree

- Estimating Subsurface Physical Parameters from Seismic Waveform Measurements Survey Taxonomy
- Full-Waveform Inversion Methods
  - Neural Network Parameterization for FWI ★ (3 papers)
  - [0] Unveiling the Mechanism of Continuous Representation Full-Waveform Inversion: A Wave Based Neural Tangent Kernel Framework (Anon et al., 2026) View paper
  - [13] Gabor wavelet-activation implicit neural learning for full-waveform inversion (Fangshu Yang, 2025) View paper
  - [21] Deep reparameterization for full waveform inversion: Architecture benchmarking, robust inversion, and multiphysics extension (Liu Feng, 2025) View paper
  - Conventional FWI Algorithms (4 papers)
  - [9] An Augmented Lagrangian Method-Based Deep Iterative Unrolling Network for Seismic Full-Waveform Inversion (Huilin Zhou, 2024) View paper
  - [15] A matrixâfree variant of the distorted Born iterative method for seismic fullâwaveform inversion (Kui Xiang, 2023) View paper
  - [33] Robust elastic full-waveform inversion using an alternating direction method of multipliers with reconstructed wavefields (Aghazade, 2024) View paper
  - [46] Reflection seismic waveform tomography (Yanghua Wang, 2009) View paper
  - Stochastic and Bayesian Inversion (3 papers)
  - [5] Accelerating targetâorientedmultiâparameter elastic fullâwaveform uncertainty estimation by reciprocity (W.A. Mulder, 2024) View paper
  - [24] Stochastic seismic waveform inversion using generative adversarial networks as a geological prior (Mosser, 2020) View paper
  - [40] FWIGAN: Fullâwaveform inversion via a physicsâinformed generative adversarial network (FangshuYang, 2023) View paper
  - Multiparameter and Elastic FWI (2 papers)

- [16] Prediction of the ocean water sound speeds via attribute-guided seismic waveform inversion (Subhashis Mallick, 2022) View paper
- [18] Integrating elastic neural network seismic waveform with petrophysical inversion framework for critical zone properties estimation (Chang Zhang, 2024) View paper

- Seismic Amplitude Inversion and Rock Physics Integration
  - Post-Stack Seismic Impedance Inversion (3 papers)
  - [22] Seismic Data Processing and Seismic Inversion in The Ray Parameter Domain: Common Reflection Point (CRP) Stack and Ray Impedance (Wahyu Triyoso, 2024) View paper
  - [23] Multi-parameter post-stack seismic inversion based on the cycle loopâsemi-supervised learning (U. N. Prabowo, 2025) View paper
  - [30] Seimic impedance inversion based on semi-supervised learning (Suzhen Shi, 2024) View paper
  - Pre-Stack Amplitude and Anisotropy Inversion (4 papers)
  - [19] Orthotropic anisotropy analysis and parameter estimation from 3D vertical seismic profile data (M. Asgharzadeh, 2021) View paper
  - [20] Estimation of Fracture Properties From Azimuthal Seismic Data Using Convolution Neural Network (Xinpeng Pan, 2024) View paper
  - [49] Use of polarization properties of seismic waves to improve Fresnel Volume Migration of three-component subsurface seismic data (H. Richter, 2023) View paper
  - [50] Horizontal Transverse Isotropy Studied Using Tools for Full-Azimuth Seismic Data Processing and an Advanced Well Logging Complex on the Example of Famennian Deposits of the Yugomashevskoye Field (A.S. Dushin, 2024) View paper
  - Rock Physics Modeling and Petrophysical Property Estimation (6 papers)
  - [25] Petrophysical Property Prediction from Seismic Inversion Attributes Using Rock Physics and Machine Learning: Volve Field, North Sea (Doyin Pelemo-Daniels, 2024) View paper
  - [31] Porosity estimation based on the shear modulus inversion of seismic shear wave (Fucai Dai, 2024) View paper
  - [35] Probabilistic petrophysical-properties estimation integrating statistical rock physics with seismic inversion (Dario Grana, 2010) View paper
  - [38] Influence of upscaling on identification of reservoir fluid properties using seismic-scale elastic constants (Shengjie Li, 2019) View paper
  - [47] Seismic inversion for reservoir properties combining statistical rock physics and geostatistics: A review (Miguel Bosch, 2010) View paper
  - [48] Seismic reflections of rock properties (Jack Dvorkin, 2014) View paper
- Supervised Deep Learning for Inversion
  - Direct Seismic-to-Property Mapping (3 papers)
  - [4] Comparison of neural networks techniques to predict subsurface parameters based on seismic inversion: a machine learning approach (Nitin Verma, 2024) View paper
  - [39] Seismic Elastic Parameter Inversion via a FCRN and GRU Hybrid Network with Multi-Task Learning (Qiqi Zheng, 2023) View paper
  - [43] Mapping full seismic waveforms to vertical velocity profiles by deep learning (Vladimir Kazei, 2021) View paper
  - Seismic Interpretation and Feature Extraction (2 papers)
  - [29] Applications of supervised deep learning for seismic interpretation and inversion (York Zheng, 2019) View paper
  - [36] SeisLFMFlow: Seismic Common Image Gathers Enhancement Using Self-Supervised Optical Flow Estimation Based on Local Feature Matching (Zhiyu Yao, 2024) View paper
- Semi-Supervised and Unsupervised Learning Approaches (2 papers)
  - [3] Estimating subsurface properties using a semisupervised neural network approach (Haibin Di, 2022) View paper
  - [44] Unsupervised learning elastic rock properties from pre-stack seismic data (Runhai Feng, 2020) View paper
- Surface-Wave and Site Characterization Methods (4 papers)
  - [11] Assessing S-wave velocity in the shallow subsurface layers of Varanasi city through a combination of passive seismic and standard penetration test measurements (Sangeeta Kumari, 2024) View paper
  - [32] A look at the blind Kumamoto experiment: combining active and passive seismic observations to avoid Rayleigh-wave mode misidentification (E. Diego Mercerat, 2023) View paper
  - [34] A review of inverse methods in seismic site characterization (J. Gosselin, 2022) View paper
  - [42] Application of surface-wave methods for seismic site characterization (S. Foti, 2011) View paper
- Specialized Inversion Applications and Contexts
  - Reservoir Characterization and Monitoring (5 papers)
  - [6] Estimation of stress and geomechanical properties using 3D seismic data (D Gray, 2012) View paper
  - [12] Integrated Characterization and Forecasting of Overpressure Mechanisms in the âNgeâ Field, Offshore Niger Delta: Insights from Rock Properties â Seismic Velocity Cross-Plot Analysis (Ideozu R U, 2025) View paper
  - [14] Identification of the bound and free fluid pore types in an Iranian carbonate reservoir through the integration of well logs, rock physics modeling, and 3D seismic data (Ahadollah Mirshadi, 2025) View paper
  - [26] The method for precise seismic detection of geological structures in underground coal mines and application (Liujun Xie, 2024) View paper
  - [27] Review of temporal variations of underground medium based on seismic waves (Yi Meng, 2024) View paper
  - Non-Traditional Media and Targets (3 papers)
  - [10] Experimental study of geophysical and transport properties of salt rocks in the context of underground energy storage (I. FalconâSuarez, 2024) View paper
  - [37] Estimation of groundwater storage from seismic data using deep learning (Timo LÃ¤hivaara, 2019) View paper
  - [45] Seasonal variations of subsurface seismic velocities monitored by the SEIS-InSight seismometer on Mars (Nicolas Compaire, 2022) View paper
- Methodological Foundations and Auxiliary Techniques (7 papers)
  - [1] Observation site selection for physical model parameter estimation towards process-driven seismic wavefield reconstruction (Nakai K, 2023) View paper
  - [2] Unveiling the Secrets of Seismic Waves (Sanjeev Rajput, 2025) View paper
  - [7] Observation site selection for physical model parameter estimation toward process-driven seismic wavefield reconstruction (Nakai K, 2022) View paper

- [8] Estimating subsurface petro-physical properties from raw and conditioned seismic reflection data: a comparative study (PK Kushwaha, 2019) View paper
- [17] Physics-guided data-driven seismic inversion: Recent progress and future opportunities in full-waveform inversion (Youzuo Lin, 2023) View paper
- [28] Estimating subsurface parameter fields for seismic migration: velocity model building (Ian F. Jones, 2015) View paper
- [41] Towards Characterizing Physical Subsurface Parameters from Seismic Waveforms of Explosions (Jennifer Harding, 2023) View paper

### Narrative

Core task: Estimating subsurface physical parameters from seismic waveform measurements. The field encompasses a diverse set of approaches organized around several major branches. Full-Waveform Inversion Methods form a central pillar, focusing on iterative optimization techniques that match observed and synthetic waveforms to recover velocity models and other elastic properties. Seismic Amplitude Inversion and Rock Physics Integration emphasizes the link between seismic amplitudes and petrophysical attributes such as porosity and fluid content, often combining statistical rock-physics models with inversion workflows. Supervised Deep Learning for Inversion leverages labeled training data to build end-to-end mappings from waveforms to subsurface parameters, while Semi-Supervised and Unsupervised Learning Approaches explore ways to reduce reliance on extensive labels by incorporating physical constraints or cycle-consistency ideas. Surface-Wave and Site Characterization Methods target near-surface imaging using surface waves and ambient noise, and Specialized Inversion Applications address domain-specific challenges such as anisotropy, fracture detection, and time-lapse monitoring. Finally, Methodological Foundations and Auxiliary Techniques provide the algorithmic and computational underpinnings—ranging from optimization strategies to uncertainty quantification—that support these inversion paradigms.

Recent work highlights a growing interest in hybrid strategies that blend classical physics-based inversion with modern neural network parameterizations. For instance, Physics Guided FWI[17] and Deep Reparameterization[21] illustrate how neural architectures can regularize or reparameterize the subsurface model space, balancing data fit with geological realism. Wave Neural Tangent[0] sits within the Neural Network Parameterization for FWI branch, exploring how neural tangent kernel theory can inform the design of network-based velocity representations. This approach contrasts with purely data-driven supervised methods like Supervised Deep Learning[29], which rely heavily on labeled examples, and with semi-supervised frameworks such as Semisupervised Subsurface[3] that incorporate unlabeled data. Compared to neighboring works like Gabor Wavelet FWI[13], which uses wavelet-domain representations to improve convergence, Wave Neural Tangent[0] emphasizes theoretical insights from neural network training dynamics to guide parameterization choices. These developments reflect ongoing efforts to marry the interpretability and physical consistency of classical inversion with the flexibility and efficiency of deep learning.

## Related Works in Same Category

The following **2 sibling papers** share the same taxonomy leaf node with the original paper:

### 1. Gabor wavelet-activation implicit neural learning for full-waveform inversion

**Authors**: Fangshu Yang, Jianwei Ma, Siwei Ma | **Year/Venue**: 2025 | **URL**: View paper

#### Abstract

Seismic full waveform inversion (FWI) is an efficient imaging method for estimating subsurface physical parameters. However, when the initial models are inaccurate or seismic data lack low frequencies, most traditional discrete grid-based FWI algorithms often encounter local minimum problems. Additionally, the inversion performance and computational cost are closely related to spatial resolution. Reparameterizing velocity models using neural networks (NNs) effectively mitigates local minimum iss...

#### Relationship Analysis

Both papers belong to the Neural Network Parameterization for FWI category, using implicit neural representations to reparameterize velocity models for improved robustness against inaccurate initial models. The original paper develops a wave-based Neural Tangent Kernel (NTK) framework to theoretically analyze CR-FWI methods and proposes hybrid representations (IG-FWI) combining INR with multi-resolution grids to balance robustness and convergence speed. In contrast, the candidate paper (WinFWI) focuses on enhancing INR-based FWI by using Gabor wavelet activation functions in a lightweight MLP architecture, emphasizing practical implementation and computational efficiency rather than theoretical NTK analysis or hybrid representations.

### 2. Deep reparameterization for full waveform inversion: Architecture benchmarking, robust inversion, and multiphysics extension

**Authors**: Liu Feng, Li Yaxing, Feng Liu, Su Rui, Yaxing Li, et al. (10 authors total) | **Year/Venue**: 2025 | **URL**: View paper

#### Abstract

Full waveform inversion (FWI) is a high-resolution subsurface imaging technique, but its effectiveness is limited by challenges such as noise contamination, sparse acquisition, and artifacts from multiparameter coupling. To address these limitations, this study develops a deep reparameterized FWI (DR-FWI) framework, in which subsurface parameters are represented by a deep neural network. Instead of directly optimizing the parameters, DR-FWI optimizes the network weights to reconstruct them, ther...

#### Relationship Analysis

Both papers belong to the Neural Network Parameterization for FWI category, using neural networks to represent subsurface parameters and improve FWI convergence. They overlap in addressing robustness to initial models and noise through neural reparameterization, with both analyzing spectral bias and multi-scale convergence behavior. The original paper focuses on theoretical analysis through a novel wave-based Neural Tangent Kernel framework to explain convergence mechanisms and proposes hybrid INR-multigrid representations, while the candidate paper emphasizes practical architecture benchmarking (U-Net, CNN, MLP) and extends the framework to multiparameter inversion using a backbone-branch structure.

## Contributions Analysis

**Overall novelty summary.** The paper develops a wave-based neural tangent kernel (NTK) framework to analyze continuous representation full-waveform inversion (CR-FWI), where subsurface parameters are represented via coordinate-based neural networks. It resides in the Neural Network Parameterization for FWI leaf, which contains only three papers including this one. This is a relatively sparse research direction within the broader taxonomy of 50 papers across approximately 36 topics, suggesting that neural network parameterization for FWI remains an emerging area compared to more established branches like Conventional FWI Algorithms or Rock Physics Integration.

The taxonomy tree reveals that this work sits within the Full-Waveform Inversion Methods branch, which also includes Conventional FWI Algorithms (four papers on traditional grid-based optimization), Stochastic and Bayesian Inversion (three papers on probabilistic frameworks), and Multiparameter and Elastic FWI (two papers on multi-parameter estimation). Neighboring branches include Supervised Deep Learning for Inversion, which focuses on direct data-to-model mapping rather than physics-informed parameterization, and Semi-Supervised and Unsupervised Learning Approaches. The scope notes clarify that this leaf excludes traditional grid-based FWI and supervised learning, positioning the work at the intersection of physics-based inversion and neural network theory.

Among 26 candidates examined across three contributions, no clearly refutable prior work was identified. The wave-based NTK framework examined six candidates with zero refutations, the eigenvalue decay analysis examined ten candidates with zero refutations, and the hybrid INR-multigrid representation examined ten candidates with zero refutations. This suggests that within the limited search scope—primarily top-K semantic matches and citation expansion—the specific combination of NTK theory applied to FWI and the proposed hybrid representation appears relatively unexplored. The theoretical analysis of optimization behavior through eigenvalue decay also lacks direct precedent among the examined candidates.

Based on the limited literature search of 26 candidates, the work appears to occupy a relatively novel position by bridging neural tangent kernel theory with full-waveform inversion. However, the sparse population of the Neural Network Parameterization for FWI leaf and the absence of refutable candidates should be interpreted cautiously, as the search scope does not guarantee exhaustive coverage of all relevant theoretical or applied work in neural network-based geophysical inversion.

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This paper presents **3 main contributions**, each analyzed against relevant prior work:

## Contribution 1: Wave-based neural tangent kernel framework for FWI

**Description**: The authors extend the neural tangent kernel theory to full-waveform inversion by introducing a wave kernel for conventional FWI and a wave-based NTK for continuous representation FWI. This framework provides a unified theoretical foundation for analyzing both conventional and CR-FWI methods through eigenvalue decay properties.

This contribution was assessed against **6 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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### 1. Laser ultrasonic imaging detection of near-surface defects based on multi-scale physics-informed neural networks

**URL**: View paper

**Brief Assessment**

Laser Ultrasonic Defects[66] focuses on laser ultrasonic imaging for near-surface defect detection using multi-scale physics-informed neural networks, not full-waveform inversion. The minimal NTK references in the candidate do not address FWI theory or wave kernel frameworks.

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### 2. Physics-Informed Neural Network for the Inverse Seismic Problem Using Neural Tangent Kernels

**URL**: View paper

**Brief Assessment**

Inverse Seismic PINN[63] focuses on physics-informed neural networks for inverse seismic problems using NTK analysis. The original paper develops a wave-based NTK framework specifically for full-waveform inversion with continuous representation methods, analyzing eigenvalue decay properties to explain robustness-convergence trade-offs in CR-FWI versus conventional FWI. Without access to the full text of the candidate paper, technical differences in problem formulation, theoretical framework, and application domain cannot be definitively assessed.

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### 3. PINNs for Learning High-Frequency Elastic Waves in Complex Layered Media

**URL**: View paper

**Brief Assessment**

High Frequency Elastic[62] focuses on physics-informed neural networks (PINNs) for solving elastic wave equations in heterogeneous media, not on full-waveform inversion or neural tangent kernel theory applied to FWI. The candidate addresses forward wave propagation problems using PINNs, while the original develops NTK theory specifically for the inverse problem of FWI.

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### 4. Integrated networks for viscoelastic FWI: mapping from Q to relaxation variables and quantifying modelling error

**URL**: View paper

**Brief Assessment**

Viscoelastic FWI Networks[61] focuses on viscoelastic full waveform inversion using neural networks for Q-to-relaxation variable mapping and modeling error quantification. It does not address neural tangent kernel theory or provide theoretical analysis of FWI convergence mechanisms, which are central to the original paper's contribution.

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### 5. Physics-Informed Neural Network for the Seismic Velocity Problem Using Neural Tangent Kernels

**URL**: View paper

**Brief Assessment**

Seismic Velocity PINN[64] applies NTK for adaptive loss weighting in a cross-well seismic scenario, not for analyzing FWI convergence behavior or establishing a unified theoretical framework comparing conventional and continuous representation FWI methods.

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### 6. Multi-Scale Physics-Informed Inversion of Densely Distributed Near-Surface Defects Using Laser Ultrasonics

**URL**: View paper

**Brief Assessment**

Multi-Scale Defects[65] focuses on laser ultrasonic detection of near-surface defects using multi-scale physics-informed inversion, not on developing a neural tangent kernel framework for full-waveform inversion. The candidate's brief mentions of NTK and FWI appear in different contexts (spectral bias and multi-scale problems) without establishing a unified theoretical framework.

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## Contribution 2: Theoretical analysis of eigenvalue decay and optimization behavior

**Description**: The authors prove that the wave-based NTK is non-stationary during training and that its eigenvalue decay is faster than the wave kernel. This theoretical result explains the robustness-convergence trade-off observed in CR-FWI methods, where rapid eigenvalue decay enables multiscale inversion but slows high-frequency convergence.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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### 1. Fast Ip solution of large, sparse, linear systems: Application to seismic travel time tomography

**URL**: View paper

**Brief Assessment**

Travel Time Tomography[58] focuses on iteratively reweighted least squares for seismic travel time inversion, not on eigenvalue decay analysis in continuous representation methods or neural tangent kernel frameworks for seismic inversion.

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### 2. Source-receiver compression scheme for full-waveform seismic inversion

**URL**: View paper

**Brief Assessment**

Source Receiver Compression[57] focuses on data compression via SVD and eigenvalue elimination to reduce computational cost in FWI, not on analyzing eigenvalue decay of neural tangent kernels or continuous representation methods.

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### 3. Spectral decomposition of ground motions in New Zealand using the generalized inversion technique

**URL**: View paper

**Brief Assessment**

Generalized Inversion Technique[51] focuses on seismic ground-motion decomposition using Fourier-domain inversion to isolate source, path, and site effects. This is fundamentally different from the original paper's theoretical analysis of eigenvalue decay in neural tangent kernels for continuous representation full-waveform inversion.

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### 4. Correlation based Bayesian modeling: with applications in travel time tomography, seismic source inversion and magnetic field modeling

**URL**: View paper

**Brief Assessment**

Correlation Bayesian[60] discusses eigenvalue spectrum decay in the context of Bayesian modeling for geophysical applications, but does not address neural tangent kernels, continuous representation methods, or full-waveform inversion optimization dynamics that are central to the original paper's contribution.

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### 5. Physics-informed Parallel Neural Networks for the Identification of Continuous Structural Systems

**URL**: View paper

**Brief Assessment**

Parallel Neural Networks[55] focuses on structural system identification using physics-informed neural networks for continuous bars, not seismic inversion. The eigenvalue analysis context differs fundamentally from wave-based NTK in full-waveform inversion.

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### 6. Detecting seismic activity with a covariance matrix analysis of data recorded on seismic arrays

**URL**: View paper

**Brief Assessment**

Covariance Matrix Detection[59] focuses on seismic activity detection using covariance matrix eigenvalue analysis for signal detection purposes, not on optimization behavior or convergence analysis in continuous representation seismic inversion methods. The contexts address fundamentally different problems.

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### 7. Geometrically-informed methods of wave-based imaging

**URL**: View paper

**Brief Assessment**

Geometrically Informed Imaging[56] focuses on wave-based imaging techniques for seismic imaging and full-waveform inversion using adjoint-state methods and Hessian analysis. It does not address eigenvalue decay in continuous representation methods or neural tangent kernel frameworks for seismic inversion.

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### 8. A mixed, unified forward/inverse framework for earthquake problems: fault implementation and coseismic slip estimate

**URL**: View paper

**Brief Assessment**

Unified Forward Inverse[54] focuses on earthquake fault slip inversion using finite-element methods and adjoint optimization. It performs eigenvalue analysis of the Hessian for uncertainty quantification in a geophysical context, not on neural tangent kernels or continuous representation methods in seismic full-waveform inversion.

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### 9. Nonstationary spectral inversion of seismic data

**URL**: View paper

**Brief Assessment**

Nonstationary Spectral[52] addresses spectral inversion for seismic reflectivity using short-time Fourier transforms and quality factor Q, not eigenvalue decay analysis in neural tangent kernel frameworks for continuous representation methods.

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### 10. Seismic Inversion Resolution Enhancement With (3S) Spectral Blueing, Spectral Balancing, and Stochastic Inversion on Fluvio Deltaic Environment

**URL**: View paper

**Brief Assessment**

Spectral Blueing Balancing[53] focuses on seismic inversion resolution enhancement in oil and gas exploration using spectral processing techniques (spectral blueing, spectral balancing, stochastic inversion). It does not address eigenvalue decay analysis, neural tangent kernels, or continuous representation methods in full-waveform inversion.

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## Contribution 3: Hybrid INR-multigrid representation for FWI

**Description**: The authors introduce IG-FWI, a new continuous representation method that integrates implicit neural representation with multi-resolution grid encoding. This hybrid approach is designed to achieve tailored eigenvalue decay properties that balance the robustness of INR-based methods with the faster convergence of grid-based methods.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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### 1. Enhanced high-resolution prediction modeling of working face reconstruction using multi-scale grid pruning and dynamic multi-population genetic algorithms

**URL**: View paper

**Brief Assessment**

Grid Pruning Genetic[74] focuses on working face reconstruction using multi-scale grid pruning and genetic algorithms for optimization, not on seismic full-waveform inversion or implicit neural representations combined with multi-resolution grids for wave equation solving.

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### 2. Gabor wavelet-activation implicit neural learning for full-waveform inversion

**URL**: View paper

**Brief Assessment**

Gabor Wavelet FWI[13] focuses on implicit neural learning with Gabor wavelet activation functions for FWI, not on hybrid INR-multigrid representations. The candidate does not discuss multi-resolution grid encoding or hybrid architectures combining INR with grid-based methods.

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### 3. Multi-scale geological modeling and in-situ stress inversion of Xincheng Gold Mine at the Jiaodong Peninsula, China

**URL**: View paper

**Brief Assessment**

Xincheng Stress Inversion[70] focuses on geological modeling and stress inversion for mining applications, not seismic full-waveform inversion or neural representation methods for wave equation problems.

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### 4. Multi-Scale Machine Learning Models for Seismic Wave Propagation

**URL**: View paper

**Brief Assessment**

Multi Scale Wave[73] focuses on seismic wave propagation modeling using convolutional networks and multiresolution transformers for rupture process reconstruction, not on full-waveform inversion with hybrid INR-multigrid representations.

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### 5. Well Log-Guided Synthesis of Subsurface Images from Sparse Petrography Data Using CGANs

**URL**: View paper

**Brief Assessment**

Well Log Synthesis[68] focuses on synthesizing subsurface images from well log data using CGANs for petrography applications, not on full-waveform inversion or hybrid implicit neural representation with multi-resolution grid encoding for seismic imaging.

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### 6. High-precision microseismic source localization using a fusion network combining convolutional neural network and transformer

**URL**: View paper

**Brief Assessment**

Microseismic Fusion Network[69] focuses on microseismic source localization using CNN-Transformer fusion for seismic event detection, not on full-waveform inversion or hybrid implicit neural representation methods for velocity model reconstruction.

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### 7. No Location Left Behind: Measuring and Improving the Fairness of Implicit Representations for Earth Data

**URL**: View paper

**Brief Assessment**

Fairness Earth Data[67] focuses on fairness assessment of implicit neural representations for Earth data across geographic subgroups, not on seismic full-waveform inversion or hybrid INR-multigrid methods for geophysical exploration.

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### 8. Neural implicit representations for grid-agnostic MPI reconstructions

**URL**: View paper

**Brief Assessment**

Grid Agnostic MPI[72] focuses on magnetic particle imaging reconstruction using neural implicit representations for arbitrary grid sampling, not seismic full-waveform inversion with hybrid INR-multigrid encoding for eigenvalue decay optimization.

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### 9. Deep prior-based audio inpainting using multi-resolution harmonic convolutional neural networks

**URL**: View paper

**Brief Assessment**

Audio Inpainting[71] addresses audio signal restoration using deep prior methods with convolutional autoencoders for time-frequency representations. This is fundamentally different from the original paper's seismic full-waveform inversion framework that combines implicit neural representation with multi-resolution grid encoding for subsurface imaging.

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### 10. Optimization algorithm for 3D image visual communication based on digital image reconstruction

**URL**: View paper

**Brief Assessment**

Image Visual Communication[75] focuses on 3D image reconstruction for visual communication using neural radiance fields and graph neural networks for texture enhancement, not seismic full-waveform inversion or hybrid implicit-multigrid representations for geophysical applications.

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## Appendix: Text Similarity Detection

No high-similarity text segments were detected across any compared papers.

## References


- [0] Unveiling the Mechanism of Continuous Representation Full-Waveform Inversion: A Wave Based Neural Tangent Kernel Framework View paper
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