

Characteristics of the RL Algorithm for Relay Protection



Overview

This paper introduces a new framework of deep reinforcement learning based protective relay design in power distribution systems with many distributed energy resources (DERs).

Key Takeaways

Reinforcement learning (RL) algorithms in relay protection are adaptive, robust, and capable of learning optimal fault detection and relay control policies without prior knowledge of the environment. Key Characteristics¹.

Adaptive Decision-

Making R

L algorithms employ an agent that interacts with the power system environment, observing states such as current, voltage, and fault conditions, and selecting actions like relay operation or power allocation. The agent learns from feedback (rewards) to optimize decisions over time, allowing the system to adapt to changing network conditions and uncertainties in real-time. 2.

Robustness to Uncertainty Unlike traditional methods that rely on exact fault current or channel state information, RL algorithms can handle incomplete or delayed measurements. They optimize relay actions based on historical interactions and probabilistic outcomes, improving worst-case performance and reducing the risk of misoperation under uncertain conditions. 3.

Multidimensional Analysis RL-based relay protection can simultaneously process multiple parameters, including current, voltage, resistance, and phase angles. This multidimensional capability enhances fault recognition accuracy and allows the system to distinguish between actual faults and transient disturbances. 4.

Communication-

Free Operation Many R

RL approaches for relay protection are designed to operate without continuous communication between relays, which simplifies implementation and reduces dependency on network infrastructure while maintaining high accuracy in fault detection. 5. Learning from Experience The RL agent improves its policy through repeated interactions with the environment, receiving rewards for successful fault isolation and penalties for incorrect actions.

This learning process enables the system to generalize to unseen fault scenarios and adapt to new network configurations. 6. Integration with Intelligent Electronic Devices (IEDs) RL algorithms can be implemented in modern digital substations using IEDs, allowing real-time monitoring and control.

This integration supports advanced relay protection automation and enhances the sensitivity and selectivity of protection schemes. 7. Enhanced Selectivity and Speed By learning optimal relay operation policies, RL algorithms can improve the selectivity of protection, ensuring that only the faulted section is isolated.

This reduces post-fault disturbances, voltage dips, and thermal stress on the network, similar to the benefits of fast-acting traditional protection but with greater adaptability. Summary RL algorithms for relay protection combine adaptive learning, robustness, multidimensional analysis, and communication-free operation to enhance fault detection and relay control. They offer significant advantages over traditional protection schemes, particularly in complex modern power grids with distributed generation and variable operating conditions, enabling faster, more accurate, and reliable protection.

Article Content

Deep Reinforcement Learning-Based Robust Protection in Electric ...

be easily applied in both a standalone relay and a network of coordinating relays. The trained RL relays can accurately detect faults under situations including high fault impedance, presence of distributed

Deep Reinforcement Learning-Based Robust Protection in DER-Rich ...

Based on the new formulation, we proposed a novel Long-Short-Term-Memory (LSTM)-enhanced RL algorithm that leads to much more reliable and accurate coordination of protective relays as

Deep Reinforcement Learning-Based Robust Protection in DER-Rich ...

This paper introduces a new framework of deep reinforcement learning based protective relay design in power distribution systems with many distributed energy resources (DERs). With increasing

Artificial intelligence algorithms enhancing relay protection and ...

In this research project, Artificial Intelligence (AI) algorithms applied to the relay protection of high and low-voltage distribution networks are investigated.

Optimization of Relay Protection Setting for Distribution Networks ...

On this basis, the optimization model of distribution network relay protection setting based on multi-scale combined kernel limit learning machine is designed, and the adaptive scheduling method is adopted

Efficient searching of extreme operating conditions for relay ...

Relay protection is a fundamental technology for ensuring the safety and stability of power systems. It functions by rapidly isolating faulty components, thereby preventing equipment damage and

(PDF) Relay Protection and Automation Algorithms of ...

The use of specialized trainable triggering elements is studied both for building new protections and for improving the sophistication of traditional types of relay protection devices.

Relay Protection and Automation Algorithms of Electrical ...

The approach involves replacement of traditional types of relay protection (current protection, distance protection, and other automatic) with decision-making systems adapted to a

(PDF) New and traditional relay protection algorithms integration in 6 ...

We demonstrated the advantages of using new differential-logic and multi-parameter relay protection algorithms, as well as the methods for relay protection tripping parameters calculation.

Optimization of Multi level Relay Protection Adaptive ...

This method fully analyzes the impact of distributed generation access on the dynamic characteristics of multi-level relay protection in distribution networks.

Fast Searching of Extreme Operating Conditions for Relay Protection ...

Abstract—Searching for the Extreme Operating Conditions (EOCs) is one of the core problems of power system relay protection setting calculation. The current methods based on brute-force search,

Optimal adaptive coordination of overcurrent relays in

Simulations and analyses substantiate the efficacy of the algorithm in optimizing the coordination among overcurrent relays aiming to uphold the

Optimization of Multi level Relay Protection Adaptive ...

By combining the overcurrent characteristics of multi-level relays with the operational principles of multi-level relay protection, the optimization objective function and constraints for the adaptive setting

Deep Reinforcement Learning-Based Robust Protection in Electric ...

Abstract—This paper introduces a Deep Reinforcement Learning based control architecture for the protective relay control in power distribution systems. The key challenge in protective relay control is

Review on Applications of Artificial Intelligence in Relay Protection ...

With the continuous development of power grid sources, networks and loads, the emergence of distributed power sources and new types of loads has brought new challenges to the

Optimal Protection Coordination of Active Distribution Networks

Much attention has been paid to the optimized protection of microgrids (MGs) and active distribution networks (ADNs). However, the literature shows a research gap in proposing a hybrid

Power System Relay Protection Based on Faster R-CNN Algorithm

Starting from the operating characteristics of relay protection, it is suitable for practical engineering applications. Aiming at the problems of low work efficiency and low inspection quality in

What is Protection Relay?

A protection relay is a crucial component of electrical systems that safeguard infrastructure, employees, and equipment from electric problems and malfunctions. It functions as a

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