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Artificial Intelligence in Power Stations

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ABSTRACT:

The integration of artificial intelligence (AI) technologies in power stations has revolutionized the way energy is generated, transmitted, and distributed. This abstract presents a comprehensive overview of the applications, benefits, and challenges of AI in power station management. Firstly, the utilization of AI algorithms such as machine learning and deep learning has significantly improved predictive maintenance, fault detection, and optimization of power generation processes. Secondly, AI-powered systems enable real-time monitoring and control, leading to enhanced operational efficiency and reliability. Moreover, the implementation of AI-driven decision support systems facilitates optimal resource utilization and grid stability. However, the widespread adoption of AI in power stations also presents challenges such as data security concerns, interoperability issues, and the need for skilled personnel. Addressing these challenges requires collaborative efforts from stakeholders across the energy sectors. This abstract highlight the transformative potential of AI in power station management and underscores the importance of continued research and development to unlock its full benefits while mitigating associated risks.

An extensive review of the uses, advantages, and difficulties of AI in power plant management is provided in this abstract. First off, the application of AI methods like deep learning and machine learning has greatly enhanced fault detection, predictive maintenance, and power generating process optimization. Second, real-time monitoring and control are made possible by AI-powered systems, which improves operational dependability and efficiency. In addition, the deployment of artificial intelligence-powered decision support systems promotes grid stability and efficient resource use.

I. INTRODUCTION

As far as the globe is aware at that point, artificial intelligence is crucial since it is a system that makes a lot of wise and excellent selections and takes appropriate actions on such tasks. Artificial intelligence is being used in various fields, including computing, power systems, and mechanical domains. Fuzzy logic is used by civilians in these fields.

extremely significant, hence in addition to them, artificial intelligence covers a wide range of other fields. Thus, the topic of this work is power plants run by artificial intelligence.

The power system is a system used in large, industrial machinery. Thus, artificial intelligence in the power system operates on large machinery such as gas turbines, heat exchangers, generators, DeNOx (SCR), etc.

Three divisions are also applied to the layers:

1. Input Layer: In this layer, the node is not processing data or information; rather, it is disrupting data and information to other units. The layer that receives input is called very start of the artificial neural network's workflow.

2. Hidden Layer: This kind of node offers a way to categorize nonlinear problems even though it is unable to show clearly and visibly. Artificial neurons process a collection of weighed inputs and use an activation function to produce an output between the input and output layers.

3. Output Layer: The output units, or nodes, encode potential values that could be assigned to the case under consideration. It is the layer of neurons that produces given output for the program.

II. LITERATURE SURVEY

In " AI's Contribution to sustainable power generation" by Simarpreet Singh 2024, the authors discuss the renewable energy industry is transforming with AI in Smart Grids optimizing various components like power generation, storage .[1].

"Applications of artificial intelligence in power system operation, control and planning": a review by Utkarsh Pandey, Anshumaan Patak , Adesh Kumar 2023 . This paper presents a comprehensive overview of diverse AI techniques that can be applied in power system operation, control and planning, aiming to facilitate their various applications.[2].

"A Review on Artificial Intelligence in power station" by Yash Kumar Bansal. 2020 In this paper author discussed about many type of issues and their solutions and many other things in this paper totally depend on power stations which is operated by artificial intelligence[3].

"Artificial intelligence in power sectors": a comparative study by Baloka Makala and Tonci Bakovic (2020) These technologies can help improve power management, efficiency, and transparency and increase the use of renewable resources[4]..

III. WORKING PRINCIPLE

The Thermal power generation plant thermal power station is the most conventional source of electric power. Thermal power plant is also referred as coal thermal power plant and steam turbine power plant. Before going into detail of this topic, we will try to understand the line diagram of electric power generation plant. The theory of thermal power station or working of thermal power station is very simple. A power generation plant mainly consists of alternator runs with help of steam turbine.

The steam is obtained from high pressure boilers. Generally in India, bituminous coal, brown coal and peat are used as fuel of boiler. The bituminous coal is used. It works on the principle of Rankine cycle. It is dangerous and highly specialized operations are required such as live maintenance of boiler.

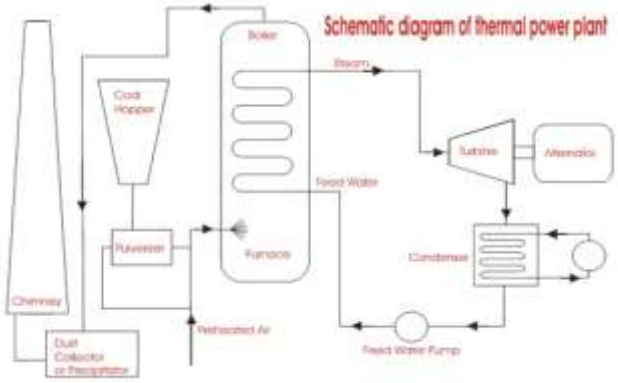

Fig1. Schematic diagram of Thermal power plant

AI TECHNIQUES:

A. ARTIFICIAL NEURAL NETWORKS

Neural networks are simplified models of the biological nervous system and therefore have drawn motivation from kind of computing performed by brain An Artificial neural network is generally a highly interconnected network of a large number of processing elements called 'Neurons' in an architecture inspired by the brain. the brain is highly complex, Non linear and parallel computer (Information processing system).It has the capabilities perform certain computations (e.g: pattern recognition, perception and motor control) many times faster than the digital computer. Neural networks derive their computing power in two ways. First massively parallel distributed structure and second its ability to learn. These two information processing capabilities make it possible for neural networks to solve complex problems.

Artificial Neural Networks are systems designed based on organic thought processes which convert a set of inputs into a set of outputs by a network of neurons. Each neuron produces one output as a function of inputs. These system are used in real world applications wherein the need for classification of patterns and pattern recognition arises.

They are classified by their architecture: number of layers and topology: connectivity pattern, feed forward or recurrent.

They are classified by their architecture: number of layers and topology: connectivity pattern, feed forward or recurrent. Input Layer: The nodes are input units which do not process the data and information but distribute this data and information to other units. Hidden Layers: The nodes are hidden units that are not directly evident and visible. They provide the networks the ability to map or classify the nonlinear problems. Output Layer: The nodes are output units, which encode possible values to be allocated to the case under consideration.

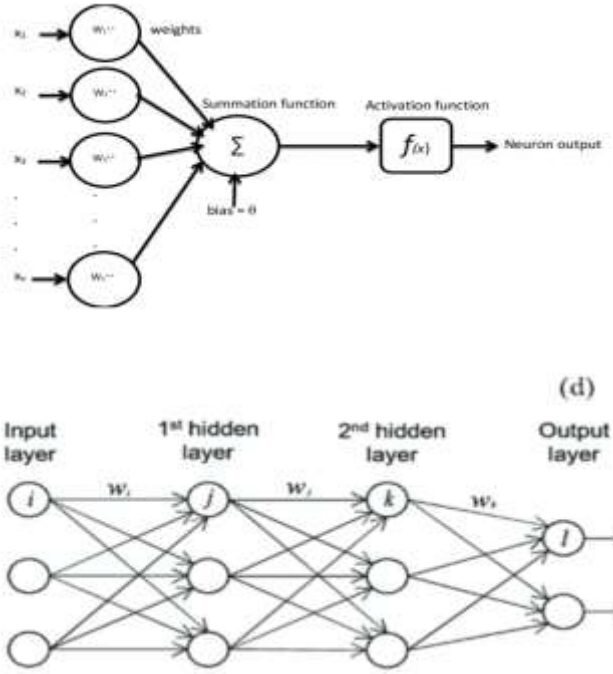

Fig2: Neural Network Architecture And Structure of ANN

IV. ADVANTAGES

- Reliability.
- Improved Safety.
- Increased efficiency.
- Sustainability.

V. APPLICATIONS

Predictive Maintenance: AI algorithms can analyze data from sensors to predict equipment failures before they occur, minimizing downtime and maintenance costs.

Energy Optimization: AI can optimize energy production and distribution by analyzing real-time data and adjusting parameters such as fuel consumption and grid load.

Fault Detection: AI algorithms can detect anomalies in power station operations, such as voltage fluctuations or equipment malfunctions, allowing for quick intervention to prevent larger issues.

Demand Forecasting: AI can analyze historical data and external factors to forecast energy demand, helping power stations adjust their production schedules accordingly to meet demand efficiently.

Grid Management: AI can assist in managing the grid by balancing supply and demand, integrating renewable energy sources, and optimizing transmission and distribution.

Safety and Security: AI-powered systems can enhance safety and security by monitoring for potential hazards, detecting intrusions, and implementing automated responses to emergencies.

VI. CONCLUSION

Reliability is the primary consideration in power system design and planning, and it was traditionally assessed using deterministic techniques. Furthermore, traditional methods fail to meet the probabilistic requirements of power systems. The expense of operation and maintenance goes up as a result. To use the present interest in Al for power system applications, a lot of research is done. The full benefits of this emerging technology for enhancing

the effectiveness of investments in the electricity market, distributed control and monitoring, and effective system analysis—particularly for power systems that run on renewable energy resources—need to be fully understood through extensive research.

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