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A STUDY ON THE REVIEW OF ARTIFICIAL INTELLIGENCE BASED POWER TRANSFORMER SECURITY SYSTEM

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ABSTRACT- The aim of this research work is to design and develop more robust protection, suited to a large number of situations, requiring a little adjustment and thus easier to install and to operate the power transformers, within this study, the simulation of some of the strategies of Artificial Intelligence (AI) is focused on the safety of the power transformer. This would be very useful for the optimal design and creation of AI-based power transformer security schemes. Today, this dimension is becoming extremely relevant due to the fact that more critical loads are attached to electrical networks and that automation is growing. These automated devices need extremely quick acquisition and control systems that can be used to detect and, likely, anticipate suspicious incidents. Artificial Intelligence (AI) methods are also favored.

KEYWORDS- Artificial Intelligence, Electrical Power, Power Transformer, Optimization Problem

INTRODUCTION

Electrical power is the gauge to advance in a country since people, industry and others signal the growth of technology amongst masses via consumption. The transformer has a pride of position in the power system, because this component bridges two circuits on their sides of supply and receipt of differing voltage levels. As the transformer is equipment of capital, it is vital to safeguard the power infrastructure in operation. The degree of advanced performance in a power system is represented by the system downtime. The highly developed world tends to keep over 95 percent

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of its service life. Protection of the transformer is essential to ensure such an uptime at all times.

In a nation, the rate of industrialization relies completely on whether continuous, dependable and clean power is available. This may be achieved via an appropriate and sufficient power system protection strategy. Power transformers are the core of the system and are important to safeguard them. There are complications in its protection because during its working phase, many of the variables are revealed, such as inrush magnetizing currents and faults of different kinds at the circuit line or at the circuit stage.

An instantaneous current, many times greater than the usual current, is a factor nearly in the circumstances of the transformer during energy generation. If discrimination is poor, this is regarded as a defect by the safeguard system. In this respect, popular differential protection strategies tend to fail. When inrush currents are identified, a switchgear operation may be observed, not as inrush currents should not be regarded as faults.

This condition of the power system protection system does not depend on the detection of intrusion currents, but on the detection of comparable size fault currents creates a highly strict condition in the capacity for discriminating of the protection system. A new method is presented in this context as a discrete approach for transforming wavelet. The system works in two stages with the analysis of transient temporal frequencies, and another step with the identification of patterns. The first step is the Discrete Wavelet Transformation (DWT) process.

1.2 ARTIICIAL INTELLIGENCE

Artificial intelligence (AI), the capacity to execute activities usually associated with intelligent humans by a computer or computer-controlled robot. The phrase is often used to use the endeavor to create systems that are characterized by human intellectual processes, such as the capacity to reason, to find meaning, to generalize, or to learn from previous experience. Since the digital computer was developed in the 1980s, it has been shown that computers can be programmed with some competence to do very difficult jobs, such as finding evidence for mathematical theorems or playing chess. Neither are their programs that can match human adaptability in broader fields nor in activities requiring considerable daily knowledge yet despite the constant progress in computer

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processing speed and memory capability. On the other hand, certain application has achieved the performance levels of human specialists and professionals in carrying out particular activities in a restricted way, such as medical diagnoses, computer search engines and voice or handwriting reconnaissance in applications as varied as artificial intelligence**.**

1.3 TRANSFORMER DESIGN OPTIMIZATION PROBLEM

The issue for transformer design optimization is that a function that is subject to multiple constraints is minimized or maximized. The common objectives include minimizing overall mass, minimizing active component costs, minimizing major material costs, reducing production costs and minimizing total ownership cost and maximizing transformer rated power. The cost of computer hardware, which gave the software technicians the possibility of automated assistance in the transformer design, was reduced considerably by the introduction of digital computers. In 1955 a first computer transformer was designed. The software package Transformer Design has been created with a user-friendly transformer design and visualization environment, whereas Jabr minimizes overall transformer bulk with a geometrical programmatic structure. Researchers have suggested a method that starts with the supposed core shape and then determines the values of electrical and magnetic parameters to optimize or reduce VA's capacity. A research showing the optimization of the transformer design utilizing a multi-design methodology examined four aims: total cost owing, mass, total losses, materials costs and five constraints: limitations on excitation current, impedance, efficiency, no load losses and total losses. The research conducted an optimal core selection to reduce core and winding losses, which takes into consideration high frequency skin and impacts on proximity in the design model, while studies showed the influence of number of primaries on transformer price variance. The research provided design optimization using MIP methods in which active transformer cost was reduced using branch and binding techniques while studies showed how the optimization of the transformer design could be accomplished using decision-making trees. Effect of environmental constraints on the cost assessment of the distribution transformer was shown in the research whereas a transformer in decentralized electric markets has shown lower cost choice.

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1.4 ARTIFICIAL INTELLIGENCE TECHNIQUES FOR TRANSFORMER DESIGN OPTIMIZATION

Artificial intelligence methods were widely applied to tackle the difficult issue of optimization of the transformer design. This section covers the use for TDO issues of several AI methods used by researchers.

1. Genetic Algorithms

Genetic algorithms (GAs) are based on fittest survival hypothesis of Darwin. J. H. Holland (1975) established the fundamental idea of GAs, while De- Jong (1975) and David Goldberg showed the feasibility of applying GAs for complicated issues (1989). Genetic algorithms were extensively used in many fields of research, business, and engineering for optimization. Widespread application, simplicity of use and worldwide perspectives were the main factors for their success.

GAs was used for reducing transformer building costs as well as decreasing work costs. GAs also used cooling system design for enhancing distribution transformers. In the research created evolutionary computational model utilizing GA, parameter identification of the power transformer was proposed. Genetic algorithms were also utilized to improve the performance of distribution transformers or core toroidal transformers for cast resin. The studies demonstrated the efficacy of the GA as an efficient search method to optimize rectifier transformer power, utilizing genetic algorithm and simulated rinsing. Study addressed the issue of transformer cost reduction by integrating genetic algorithms with the technique of Finite Element utilizing external elitism. A research provided hybrid optimum design of a distribution transformer, which integrated the finite element of 2-D, the genetic algorithm and the deterministic algorithm in order to obtain the final solution. In research, which used a sanctions method to process objective functions with weighted coefficients, the optimal transformer design was shown based on total ownership costs utilizing the simplicity of genetic algorithms.

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2. Artificial Neural Networks

Artificial Neural networks examine the computer models based on theories and observation of the structure and function of biological neural cell networks in the brain. It is usually intended to solve mathematics, computer and engineering issues as models.

The primary emphasis was on reducing iron losses of mounted transformers in Artificial Neural Networks (ANN) for the prediction of magnetic transformers core characteristics and core loss while estimating the cost of transformers using ARN was suggested during design stage. The quality improvements of wound core distribution transformers were investigated via evolutionary programming in combination with neural networks. Using the available information from the daily load curve, an ANN distribution transformer loss assessment was conducted using research in which the utility does not have to undertake load profile measurements for all types of customers. Assessing imbalanced supply status iron loss using neural networks was studied while optimizing the manufacturing process of each core using Taguchi techniques as well as minimizing iron losses was shown. Researcher used the neural network model to identify transformer oil's service life by applying the created models of ANN to ten distinct operational transformers of the known voltage of the transformer oil. Modeling of the power transformer with non-linearities based on complicated and valued open recurring neural networks was suggested.

Artificial neural networks have also been widely utilized to identify abnormal transformer conditions. The research has created an online approach for the detection of differentiation between inroad and fault streams in transformers using wavelet signals as a training input to ANN. The first identification of errors in a transformer was shown in research utilizing data from the dissolved gas analysis as an input to the formation of neural networks, and fault diagnosis using ANN were investigated. In a research using distinct neural network models for classification and interpretation of various kinds of faults, the use of artificial neural networks was envisioned. The study also addressed the detection of internal winding faults using neural networks while research was conducted utilizing electronic nose and neural networks for the diagnosis of power transformers with internal faults.

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3. Swarm Intelligence

Swarm Intelligence is the collective intelligence study of computer systems. The cooperation between many homogeneous environmental agents results in the emergence of collective intelligence. For example, the flock of birds, the fish school, or the ant's colony. Two major subfields form this paradigm. 1) Ant Colony Optimization (ACO) and 2) Particle Swarm Optimization (PSO) that explores probabilistic school, flock or herding-inspired methods. (1) Swarm Intelligence algorithms are considered adaptable methods, usually used for issues of search and optimization.

There has been a rising interest in the solution of TDO issues using swarm intelligence algorithms among academics recently.

The research carried out an optimum choice of turns in primary winding using ACO to reduce the transformer costs. The study improved the size of the tap changer setting in a transmission system to enhance the voltage stability. ACO has also been utilized to provide a projected load in the optimum selection of transformer sizes. The researchers used optimal tolerance design issues to produce power transformers that maximized the efficient use rates of sheet material for the construction of core columns of power transformers. The cost estimate using traditional techniques, GA and PSO reveals that the PSO algorithm is somewhat higher than other two approaches. Swarm intelligence approach for training a multilayer neural network for discriminating between superconducting inrush currents and faulty currents was used in a research showing that the neural network's particle swarm optimization technique is more precise than traditional methods of back spreading. An improved optimization algorithm for particle swarm was used for the optimal design of rectifier transformers in the traditional PSO algorithm in order to avoid the trapping fault in the optimum location.

Another Swarm based AI technology, the Bacterial Foraging Optimization Algorithm (BFOA), for optimization and control, has generally been approved as a worldwide optimization algorithm. The research utilized BFOA to correctly estimate parameters from one stage core transformers using BFOA. BFOA was applied in a single-phase transformer design.

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4. Multi-objective Optimal transformer Design using Evolutionary Algorithms

If just one goal is involved in an optimization issue, the effort to discover an optimum solution is known as one-sided optimization. However, if there are more than one goal in the issue of optimization, it will be called the multi-objective optimization to discover one or more optimal solutions. There are many goals for many real-world search and optimization issues. Multi-target optimization via evolutionary algorithms has become popular since a solution population is processed during each generation. This characteristic offers an enormous benefit to evolutionary algorithms for their application in multi-objective optimization issues.

Differential algorithm evolution approach based on truncated gamma probability distribution functions has been shown in the study, while unrestricted population sizes combined with chaotic sequences used evolutionary multi-objective optimization approaches which combine the advantages of unrestricted population sizes with evolutionary multi-objective optimization for the Multi-objective design optimization by genetic algorithms of high frequency transformers was addressed in the research, while considering efficiency maximization and cost reduction by optimization of particulate swarm. In the research, Transformer design was also used for the approximate estimate of transformer design requirements using multi-objective evolutionary optimization. In a research that attempted to simultaneously maximise efficiency and reduce the cost of a 500 kVA transformer, the multi-objective optimized design of a transformer utilizing bacterial boosting algorithm was proposed.

1.5 TRANSFORMER

In most instances, the miscarriage of the two winding settings is of the many kinds of faults that impact the power transformer, such as S-L-G, L-L-G and L-L-L faults. When utilized for interturn error detection, the differential protection has its own limits. A distinguishing relay with high speed and distortion is often employed to identify these faults in the case of secondary winding faults.

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1.7 MODERN BIO-INSPIRED ARTIFICIAL INTELLIGENCE TECHNIQUES SUGGESTED FOR TDO

This section covers some of the current bio-inspired AI technology used to optimize transformers.

1. Artificial Bee Colony (ABC) Algorithm

The Artificial Bee colony mimics a honeybee swarm's sophisticated drilling activity. In the ABC model, three bee groups: employees, viewers and scouts are part of the colony. Only one artificial bee for each source of food is expected to be used. Therefore, in the colony the number of bees engaged is equal to the number of sources of food surrounding the hive. Employed bees travel to their food supply and return in this region to hive and dance. The bee whose diet has been abandoned becomes a scout and begins to seek a new source of food. Viewers observe bee dances and choose food sources according on the dances.

Other populational algorithms such as genetic algorithms, particle swarm optimization, differential evolution algoritm, and evolution strategy have better or comparable results to the ABC algorithm. The structural optimization issue and actual parameter optimization were effectively implemented using the ABC algorithm.

2. Algorithm of Bat

On the basis of the echolocation activity of bats and early research the Bat algorithm (BA), this is an extremely promising algorithm. echolocation is used to distinguish between food / prey and background obstacles in bats algorithm. Each virtual bat flies at random at 'XI' velocity (Solution) with variable wavelength or frequency and 'Ai' loudness. It alters frequency, loudness and the pulse emission rate 'r' as it seeks and finds its beard. Loudness decreases as a bat is close to the prey while the pulse rates are increasing. A local random stroll intensifies the search. The best selection continues until certain stop conditions have been satisfied.

For engineering design optimization, Bate Algorithm has been effectively utilized, and its comparison to GA, PSO and other techniques shows that BA has benefits from other algorithms.

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3. Cuckoo Search Algorithm

The Cuckoo search (CS) is an algorithm of optimization inspired by the breeding of some cuckoo species in the nests of other host birds. Each cuckoo lays one egg at a time in a search technique and puts their egg into a selected nest randomly. The finest egg nests will pass over to the following generation. The number of host nests accessible is fixed, and a host bird with a probability pa is able to detect the egg deposited by a cuckoo (0,1). Afterwards, the worst identified nests (solutions) will be eliminated.

Cuckoo has been used to search for many optimization issues and other meta-heuristic methods may seem to be exceeding in applications. Cuckoo has been used for issues in engineering optimization, nursery scheduling, data fusion in wireless sensor networks and challenges in NP hard combinatorial optimization such as travelling salesmen.

4. Firefly Algorithm

The Firefly Algorithm (FA) is a flash behavior-inspired meta-heuristic algorithm. Firefly's primary function is to serve as a signal system in which additional fires are attracted. All fireflies are supposed to be unisexual in the firefly algorithm. A specific firefly's appeal is commensurate with its luminosity. The less bright one moves towards brighter one with both fireflies, but the luminosity diminishes with increasing distance. It moves randomly when there are no fireflies, lighter than a particular firefly. In FA, luminosity is linked to objective function

In noisy nonlinear optimization issues, the Firefly algorithm has been effectively used with the DSTATCOM to resolve economic load delivery difficulties, unit dedication and power quality development.

5. Flower Pollination Algorithm

The flow pollination algorithm (FP) has been inspired and is superior than GA and PSO by the process of flow pollination of blooming plants. Biotic and cross-pollination is seen in FP as an international contamination process, with pollinators moving in a manner based on Levy flights. Biotic and self-pollination are utilised for local pollination. Pollinators such as insects may

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produce floral constancies which correspond to the likelihood of reproduction proportionate to the similarity of two of the involved flowers. A change in the likelihood of local and global pollination [0, 1] with a small bias to local pollination may influence the shift or interaction between local and global contamination.

A restricted global optimization process, wireless sensor network optimization, financial load dispatch issue and big integer programming problems have also been used to the Flower pollination algorithm.

6. Shuffled Frog Leaping Algorithm (SFLA)

The frog sapping algorithm is a method of optimization inspired by a bunch of frogs' behaviors. The population is made of frogs divided into so-called memeplex subsets. The many memeplexes are examined with distinct frog cultures, each conducting a local search. The individual frogs contain ideas inside each memeplex, that may be affected by the ideas of other frogs and develop in a process of memetic evolution. Until the convergence requirements are met, local searches and shuffles are carried out.

The SFLA research team successfully used DG optimally for location and size in radial distribution networks, while SFLA examined the economic freight transmission utilizing SFLA with Valve Point Effect. SFLA also has an application for project management and ongoing optimization.

LITERATURE REVIEW

Urooj Shabana (2020) Due to core material behaviour and loss, which lead to transformer efficiency deterioration. This article assesses the transformer's optimum performance with the conception of a new core material, Mo.Me6. There is an evident potential of an efficiency increase for the planned transformer type presented. A comparison analysis based on the different designs of the transformer type with different core materials is also conducted. The design and assessment of the transformer for actual applications is carried out using the Maxwell ANSYS electronic desktop. Whether it's a power transformer with low-frequency uses, such as circuit rectification or

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power distribution system for higher frequency applications, In order to improve the total three-phase transformer, every transformer design requires performance assessments in the working field and greater efficiency. This article contains Mo.Me6 material, the transformer efficiency and optimum core design with enhanced physical characteristics. The criteria include modifications to certain effective core characteristics, leading to progress in transformer operational effectiveness. There is a chance to choose the required material, especially for customers, so it is more dependable and appropriate for different changing circumstances. This article proposes core design using ANSYS methods to improve the efficiency and efficiency of transformers by reducing their losses.[1]

DharaShah, Tanha Talaviya (2020) In the economic sector, agriculture plays an important role. The primary focus and growing topic in the globe is agricultural automation. The population is growing enormously and the need for food and jobs is also rising. These criteria were not satisfied by the conventional techniques employed by the farmers. New automated techniques have thus been introduced. These new techniques fulfilled the food needs and provided billions of people with job possibilities. Artificial agricultural intelligence has led to a revolution in agriculture. This technique safeguarded agricultural yields against many variables such as climate change, population expansion, jobs and food security concerns. This article focuses on the many applications of artificial intelligence in agriculture, e.g. for irrigation, weeding, sensor spraying, and other methods integrated into robots and drones. These technologies conserve extra water, pesticides and herbicides, preserve soil fertility, and assist to utilize human power efficiently and increase production, as well as quality. This article looks at the work of several academics to provide a short summary of the present application of automation in agriculture, robots and drones in weeding systems. Two automated weaving approaches will be explored using the different soil water sensing technologies. The deployment of drones is addressed, as well as different techniques utilized for spraying and plant surveillance by drones. [2]

Ranadheer Radharapu Kumar (2017) In dependable and safe operation of a complex power system, protection systems may play an important and crucial role. The protective system should not only be very dependable, sensitive, selective, but also precise and quick as a key and essential

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component of the electricity system. A type of extremely essential, important and costly electric power systems equipment includes large power transformers. High demands are thus placed on protective relays for power transformers. But protection of big power transformers is one of the most difficult issues in the transmission of power systems due to their complicated working circumstances. Advanced technology in digital signal processing and AI approaches to the safety of power systems, offer the tools to improve traditional protection principles and to make power transformers more secure and reliable. Input signals are filtered out more precise, sophisticated corrections are easy to use, hardware is standardized and can communicate with other protection and control system; relayed relays are self-monitoring capable. The microprocessor technology offers an unquestionable improvement in the protection of relays – criteria signaling are measured in short time. All this, however, did not constitute an important advance in the protection of the energy system in terms of security, reliability and speed. The main explanation for this is in the absence of the decades-long requirements in the principles used by digital relays. But the relay job is approachable as a pattern recognition issue - the relay clashes continuous transients between internal failures and all other circumstances by monitoring their inputs. Alternatively, protective relaying may be regarded as an issue of decision-making - the relay should determine whether to ride or retrain. This discovery goes straight to AI in the protection of the power grid. The artificial neural network approach (pattern recognition) and the system of the experts and fluid logic approach (decision making) are also included in practice.). [3]

Omorogiuwa Eseosa (2015) The transformer, which has a large role in power production, transmission and distribution system, is one of the main components of the dependability of the power system. The transformation of the voltage of each transformer depends on the design complexity. But new references addressing new technology that meet international restrictions, low weight, compact size and excellent performance for economic viability are emerging into the market, with the rapidly changing technologies in the energy sector, Current transformer design research shows continuing interest in the use of smart technology to optimize transformer design. This paper provides the literature and general foundation for transformational design and optimization research and development in the last 42 years, based on more than 80 publishing

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papers. This paper is based on intelligent technology. This work serves as a reference point for education on current research in this area and stimulates greater interest in study. [4]

H. Mehta, R. M. Patel (2014) the electric transmission and distribution networks are essential to transformers. In order to provide these data to the producer, Transformer Design aims to gather the dimension of all components of the transformer. The transformer must be developed to be cost effective, weight small, performance excellent and, at the same time, comply with all international standards. The transformer is intended to meet these requirements. Many researchers have used transformer design optimization (TDO) and performance analysis methods for artificial intelligence (AI). The actual potential of AI technology for TDO issues has, however, yet to be completely explored. This article provides a short overview of transformers research and development using traditional optimization methods, optimization approaches based on artificial intelligence and proposes some of the new bio-inspired AI techniques that may help with TDO issues. [5]

M. Jha, Barle Nisha (2014) Power transformers play a significant role in electric power transmission and their interruption causes financial losses, thus monitoring their condition is necessary and efficiency for the dependability of the power system is effective. In this article, both probabilistic neural network (PNN) and interval type 2 Fuzzy Vector Support Machine have benefits of the approach presented (IT2FSVM). Firstly, primary and secondary three-phase streams are extracted, and the search coils are transformed by differential voltage by wavelet and utilized as probabilistic neural network inputs. AI methods are used for the classification of transformer problems on the basis of the gas data obtained. These characteristics are used for the categorization of defects as input data for the PNN and IT2FSVM combinations. The NTPC Korba-India experimental data is utilized to assess the method's performance. The outcomes of the several DGA approaches are categorized using AI methods. The PNN with IT2SVM has shown to be of the best performance when detecting the kind of transformer failure compared to the results produced with the AI methods. The test findings show that the PNN + IT2SVM method may considerably enhance diagnostic precisions for the categorization of power transformer faults.

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Furthermore, the objective of the research is to investigate the impact jointly utilized by PNN and IT2SVM on classification performance. [6]

H. D. Mehta (2012) the electric transmission and distribution networks are essential to transformers. In order to provide these data to the producer, Transformer Design aims to gather the dimension of all components of the transformer. The transformer must be developed to be cost effective, weight small, performance excellent and, at the same time, comply with all international standards. The transformer is intended to meet these requirements. Many researchers have used transformer design optimization (TDO) and performance analysis methods for artificial intelligence (AI). The actual potential of AI technology for TDO issues has, however, yet to be completely explored. This article provides a short overview of transformers research and development using traditional optimization methods, optimization approaches based on artificial intelligence and proposes some of the new bio-inspired AI techniques that may help with TDO issues. [7]

Seifeddine Souahlia (2012) This article offers an intelligent method to fault classification of the dissolved gas analysis power transformer (DGA). In order to enhance the accuracy of interpretation for the DGA of power transformers, DGA fault diagnostic methods and artificial intelligence (AI) approaches are used. The conventional DGA techniques are used to choose the best gas signature. AI methods are used for the classification of transformer defects based on the gas data obtained. Functionality is used as input data for the categorization of defects in fuzzy logic, artificial nervous network (ANN) and vector support machines (SVM). To assess the performance of the technique suggested, experimental data from the Tunisian Electricity and Gas Company (STEG) are utilized. The findings of the different DGA methods are categorized using AI approaches and comparison with the empirical tests. The DGA ratios were proven to be the most outstanding way of detecting the transformer failure type when compared to the findings produced from the AI methods. The test results show that the SVM method may substantially enhance the diagnostic accuracy for the categorization of power transformers. [8]

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CONCLUSION

Artificial neural networks have also been widely utilized to identify abnormal transformer conditions. The research has created an online approach for the detection of differentiation between inroad and fault streams in transformers using wavelet signals as a training input to ANN. These automated devices need extremely quick acquisition and control systems that can be used to detect and, likely, anticipate suspicious incidents. Artificial Intelligence (AI) methods are also favored. The development of new microprocessor-based relays and AI techniques appropriate for use in power system defense continues to be a significant part of the current work. The many advances in the field of the protection of power transformers are discussed in a literature review.

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