ISSN: 2278-4632
Vol-12 Issue-10 No.02 October 2022

A STUDY OF ENVIRONMENTAL EFFECTS ON VARIOUS INSULATORS AND ASSESSING THEIR RISK

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ABSTRACT:

Insulators of the electrical power grid are usually installed outdoors, so they suffer from environmental stresses, such as the presence of contamination. Contamination can increase surface conductivity, which can lead to system failures, reducing the reliability of the network. The identification of insulators that have their properties compromised is important so that there are no discharges through its insulating body. To perform the classification of contaminated insulators, this paper presents computer vision techniques for the extraction of contamination characteristics, and a neural network (NN) model for the classification of this condition.

Specifically, the Sobel edge detector, Canny edge detection, binarization with threshold, adaptive binarization with threshold, threshold with Otsu and Riddler–Calvard techniques will be evaluated. The results show that it is possible to have an accuracy of up to 97.50% for the classification of contaminated insulators from the extraction of characteristics with computer vision using the NN for the classification. The proposed model is more accurate than well-established models such as support-vector machine (SVM), k-nearest neighbour (k-NN), and ensemble learning methods.

In this paper, a review of the influence of environmental factors on high-voltage (HV) materials and components is provided. Sensing and artificial intelligence (AI) technologies developed to prevent the failure of the material structure and HV components are also reported.

KEY WORDS:neural network,Canny edge detection,Sobel edge detector,Riddler–Calvard techniques, artificial intelligence,support-vector machine.

INTRODUCTION:

The increase in recent power failures, with negative impacts on humans and the economy, has been largely attributed to environmental effects and the aging of the power network. These have been accelerated in the last years due to two main factors: an increased load on the power network and material degradation owing to the presence of environmental pollutants. These factors together with specific weather conditions create the incipient conditions for power network degradation. In this paper, a review of the influence of environmental factors on high-voltage (HV) materials and components is provided. Sensing and artificial intelligence (AI) technologies developed to prevent the failure of the material structure and HV components are also reported. Outdoor insulators may experience stress due to severe environmental conditions, such as pollution and contamination. Through the identification of partial discharges by ultrasonic noise, it is possible to assess the possibility of a power grid failure occurring. In this paper, ensemble models are used to analyze an ultrasonic signal from an ultrasonic microphone Pettersson M500. As the insulators are susceptible to developing irreversible failures, it will be evaluated whether the ultrasonic signal will remain over time, so that it is possible to assess whether the discharges being captured can result in a failure in contaminated polymeric insulators, evaluated in a high voltage laboratory under controlled conditions.

The surface contamination of electrical insulators can increase the electrical conductivity of these components, which may lead to faults in the electrical power system. During inspections, ultrasound equipment is employed to detect defective insulators or those that may cause failures within a certain period. Assuming that the signal collected by the ultrasound device can be processed and used for both the detection of defective insulators and prediction of failures, this study starts by presenting an experimental procedure considering a contaminated insulator removed

ISSN: 2278-4632
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from the distribution line for data acquisition. Based on the obtained data set, an offline time series forecasting approach with an Adaptive Neuro-Fuzzy Inference System (ANFIS) wasconducted.

The comparison with other models shows that the proposed algorithm is superior to well-consolidated models like SVM, kNN, and ensemble learning methods. For the compared models, the best result was 90.91% accurate. The variation in the number of folds did not result in a variation in accuracy in some models evaluated in this comparison. In the future, the classification of the insulator's conditions may be evaluated in the field, considering that the models presented can be used successfully for the classification of contamination.

LITERATURE SURVEY:

Warren Mc Cullough et.al first proposed neural networks in 1944 in University of Chicago researched who moved to MIT in 1952 as founding member of what's sometimes called he first cognitive science department. Neural nets were a major area of research in both neuroscience and computer science until 1969, when, according to computer science lore, they were killed off by the MIT mathematicians Marvin Minsky and Seymour Papert, who a year later would become codirectors of the new MIT Artificial Intelligence Laboratory.

Gabriel Villarrubia Gonzalez et.al having studied the Master in Intelligent Systems at the University of Salamanca (2012). Throughout his training he has followed a welldefined line of research, focused on the application of multi-agent systems to ambient intelligence environments, with special attention to the definition of intelligent architectures and the fusion of information. He has participated in more than 30 research projects, collaborating in the obtaining of 15 intellectual properties, having carried out international stays. In the scientific field, he is the author of more than 40 scientific publications and co-director of 50 degree projects.

Andrew Ng el.at has served as the director of the Stanford Artificial Intelligence Lab (SAIL), where he taught students and undertook research related to data mining, big data, and machine learning. His machine learning course CS229 at Stanford is the most popular course offered on campus with over 1000 students enrolling some years. As of 2020, three of most popular courses on Coursera are Ng's Machine Learning.

In 2008 his group at Stanford was one of the first in the US to start advocating the use of GPUs in deep learning. The rationale was that an efficient computation infrastructure could speed up statistical model training by orders of magnitude, ameliorating some of the scaling issues associated with big data. At the time it was a controversial and risky decision, but since then and following Ng's lead, GPUs have become a cornerstone in the field.

Geoffrey Hinton et.al has received his BA in Experimental Psychology from Cambridge in 1970 and his PhD in Artificial Intelligence from Edinburgh in 1978. He did postdoctoral work at Sussex University and the University of California San Diego and spent five years as a faculty member in the Computer Science department at Carnegie Mellon University.

METHODOLOGY:

1.FUZZY LEARNING IN ARTIFICIAL INTELLIGENCE

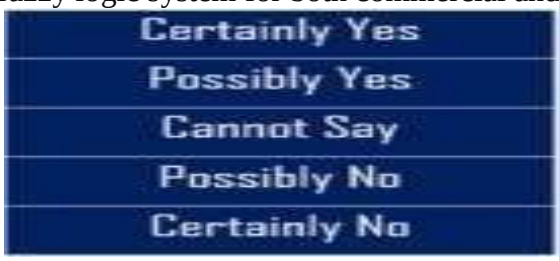
Fuzzy Logic (FL) is a method of reasoning that resembles human reasoning. This approach is similar to how humans perform decision making. And it involves all intermediate possibilities between YES and NO. The conventional logic block that a computer understands takes precise input and produces a definite output as TRUE or FALSE, which is equivalent to a human being's YES or NO. The Fuzzy logic was invented by Lotfi Zadeh who observed that unlike computers, humans have a different range of possibilities between YES and NO, such as:

- The Fuzzy logic works on the levels of possibilities of input to achieve a definite output. Now, talking about the implementation of this logic:
- It can be implemented in systems with different sizes and capabilities such as micro-controllers, large networked or workstation-based systems.

Also, it can be implemented in hardware, software or a combination of both.

ISSN: 2278-4632
Vol-12 Issue-10 No.02 October 2022

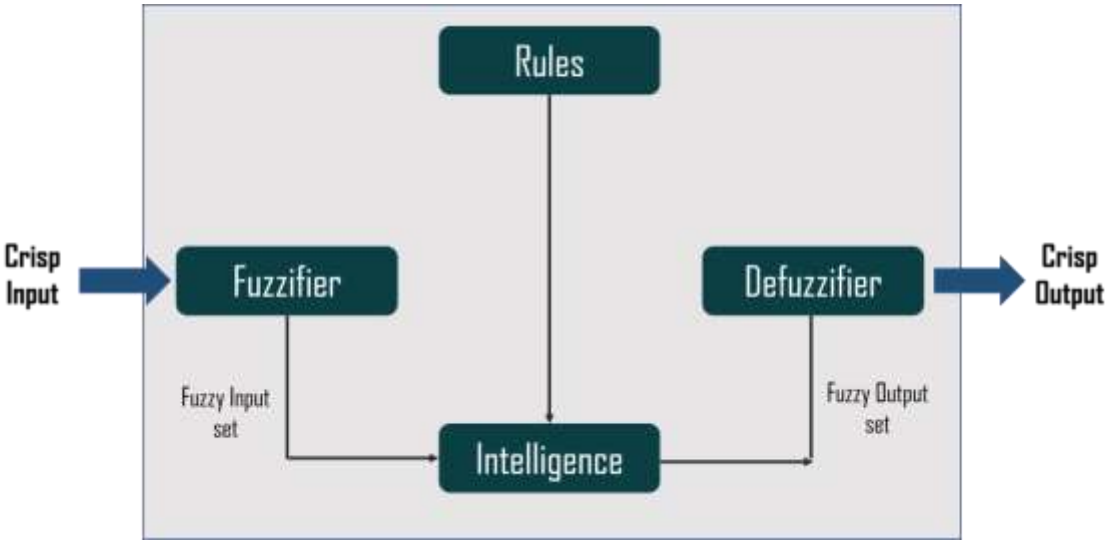
Generally, we use the fuzzy logic system for both commercial and practical purposes such as:



- It controls machines and consumer products If not accurate reasoning, it at least provides acceptable reasoning . This helps in dealing with the uncertainty in engineering .

Fuzzy Logic Architecture:

The fuzzy logic architecture consists of four main parts:



Rules – It contains all the rules and the if-then conditions offered by the experts to control the decision-making system. The recent update in the fuzzy theory provides different effective methods for the design and tuning of fuzzy controllers. Usually, these developments reduce the number of fuzzy rules.

Inference Engine – It determines the degree of match between fuzzy input and the rules. According to the input field, it will decide the rules that are to be fired. Combining the fired rules, form the control actions.

Defuzzification – The Defuzzification process converts the fuzzy sets into a crisp value. There are different types of techniques available, and you need to select the best-suited one with an expert system.

Fuzzification – This step converts inputs or the crisp numbers into fuzzy sets. You can measure the crisp inputs by sensors and pass them into the control system for further processing. It splits the input signal into five steps such as-

LP	X is Large Positive
MP	X is Medium Positive
S	Small
MN	X is Medium Negative
LN	X is Large Negative

2 .NEUTRAL NETWORKS IN ARTIFICIAL INTELLIGENCE:

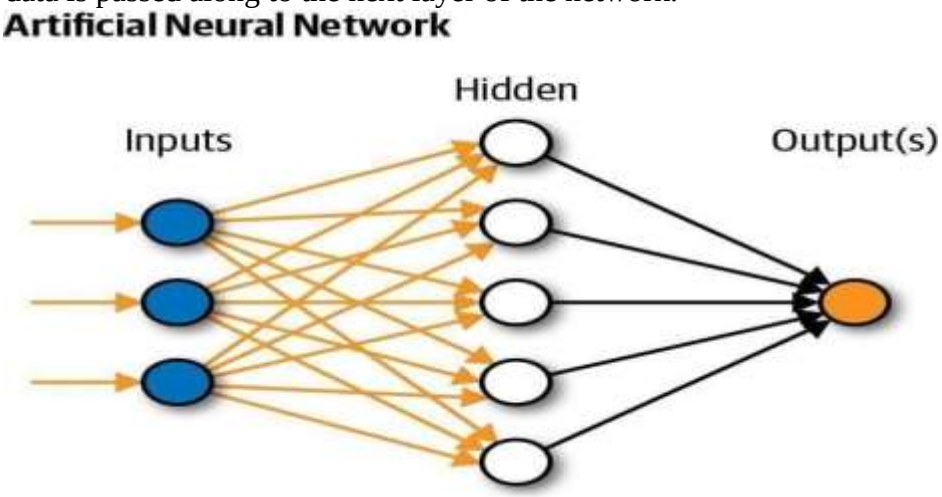
Artificial Intelligence (or AI) is a field in computer science that focuses on solving problems by applying learning techniques (and some math).In some ways, AI and the field, in general, focuses on building programs that try and imitate the way your own brain works.Neural

ISSN: 2278-4632
Vol-12 Issue-10 No.02 October 2022

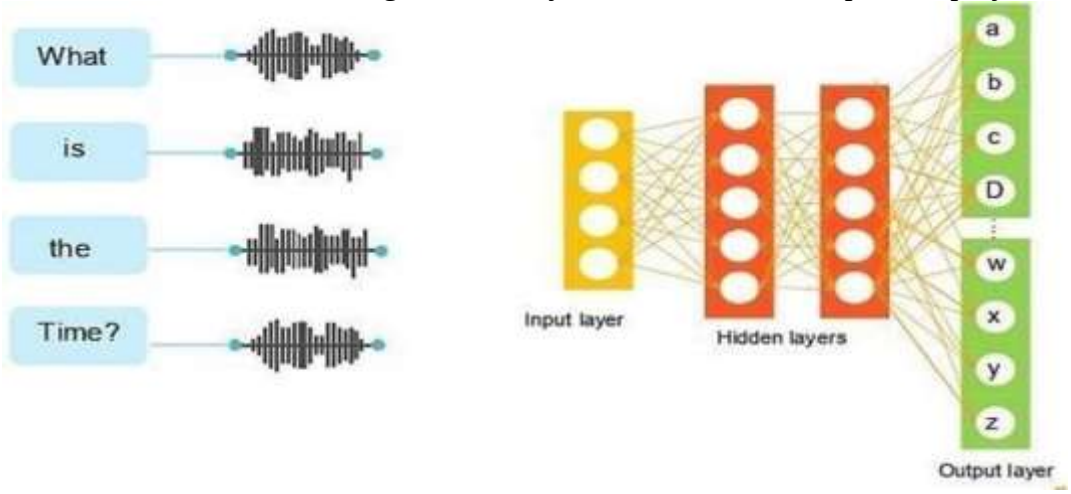
networks reflect the behavior of the human brain, allowing computer programs to recognize patterns and solve common problems in the fields of AI, machine learning, and deep learning.

Neural networks, also known as artificial neural networks (ANNs) or simulated neural networks (SNNs), are a subset of machine learning and are at the heart of deep learning algorithms. Their name and structure are inspired by the human brain, mimicking the way that biological neurons signal to one another.

Artificial neural networks (ANNs) are comprised of a node layers, containing an input layer, one or more hidden layers, and an output layer. Each node, or artificial neuron, connects to another and has an associated weight and threshold. If the output of any individual node is above the specified threshold value, that node is activated, sending data to the next layer of the network. Otherwise, no data is passed along to the next layer of the network.



Neural networks rely on training data to learn and improve their accuracy over time. However, once these learning algorithms are fine-tuned for accuracy, they are powerful tools in computer science and artificia intelligence ,allowing us to classify and cluster data at a high velocity. Tasks in speech recognition or image recognition can take minutes versus hours when compared to the manual identification by human experts. One of the most well-know nural networks is Google's search algorithm.Chemical compound identification One of the most significant technological hurdles is the time it takes to train networks, which frequently demand an acceptable level of computational power for even complex tasks. The second factor to consider is that neural networks are computer systems in which the user categorises the trained data and gets responses. Neural networks have a remarkable ability to retrieve meaningful data from imprecise data, that is used in detecting trends and extract patterns that are difficult to understand either by computer or humans. A trained NN can be made an "expert" in the information that has been given to analyze and can be used to provide projections



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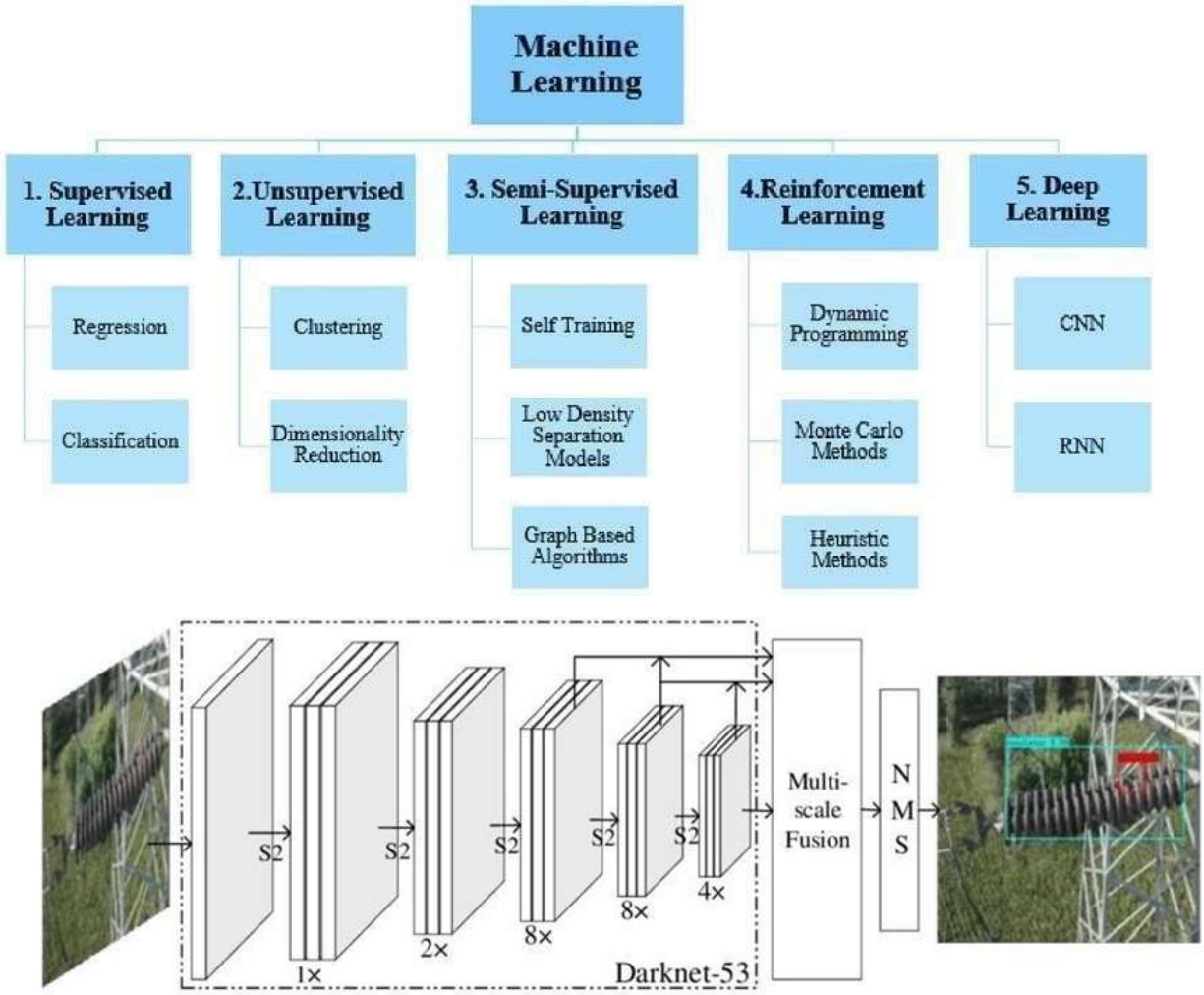
3.MACHINE LEARNING:

Machine learning is a subfield of artificial intelligence, which is broadly defined as the capability of a machine to imitate intelligent human behavior. Artificial intelligence systems are used to perform complex tasks in a way that is similar to how humans solve problems.The goal of AI is to create computer models that exhibit "intelligent behaviors" like humans, according toBorisKatz,aprincipal research scientist and head of the InfoLab Group at CSAIL. This means machines that can recognize a visual scene, understand a text written in natural language, or perform an action in the physical world. Machine learning is one way to use AI. It was defined in the 1950s by AI pioneer

Arthur Samuelas"the field of study that gives computers the ability to learn without explicitly being programmed."The definition holds true, according toMikey Shulman, a lecturer at MIT Sloan and head of machine learning atKensho,which specializes in artificial intelligence for the finance and U.S. intelligence communities. He compared the traditional way of programming computers, or "software 1.0," to baking, where a recipe calls for precise amounts of ingredients and tells the baker to mix for an exact amount of time. Traditional programming similarly requires creating detailed instructions for the computer to follow Machine learning starts with data — numbers, photos, or text, like bank transactions, pictures of people or evenbakery items,repair records, time series data from sensors, or sales reports. The data is gathered and prepared to be used as training data, or the information the machine learning model will be trained on. The more data, the better the program.



"The function of a machine learning system can be **descriptive**, meaning that the system uses the data to explain what happened; **predictive**, meaning the system uses the data to predict what will

ISSN: 2278-4632
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happen; or **prescriptive**, meaning the system will use the data to make suggestions about what action to take," the researchers wrote.

There are three learning subcategories of machine:

Supervised machine learning models are trained with labeled data sets, which allow the models to learn and grow more accurate over time. For example, an algorithm would be trained with pictures of dogs and other things, all labeled by humans, and the machine would learn ways to identify pictures of dogs on its own. Supervised machine learning is the most common type used today.

In **unsupervised** machine learning, a program looks for patterns in unlabeled data. Unsupervised machine learning can find patterns or trends that people aren't explicitly looking for. For example, an unsupervised machine learning program could look through online sales data and identify different types of clients making purchases.

Reinforcement machine learning trains machines through trial and error to take the best action by establishing a reward system. Reinforcement learning can train models to play games or train autonomous vehicles to drive by telling the machine when it made the right decisions, which helps it learn over time what actions it should take.

CONCLUSIONS:

The techniques of separate computer vision applied in the model result in a satisfactory accuracy for the classification, however, the combination of all the techniques presented in this work results in higher accuracy, in this way the use of more techniques for extraction of characteristics is promising for the classification. The evaluation of the activation function and the optimizer are extremely important for a better classification considering that some optimizers result in low accuracy in the model. The optimizers NADAM and ADAM had the best accuracy results for the classification discussed in this work.

Statistical analysis shows that the model can have a high variance, however, the average result remains high and even in the worst case, the accuracy is acceptable for the classification in question. The average accuracy found from 50 simulations is 93.10%, with 86% of the results being higher than 92.5%, when the normal distribution is evaluated. This result occurs because in the normal distribution, the values are distributed according to their greater proximity to the values defined for each class, which in this case the classes were generated from a variation of 2.5%. The conclusion is that the effect of environment on the insulators can be analysed accuratelyusing computer vision techniques like machine learning neural vision and fuzzy learning methods**.**

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