

Measurement and evaluation of transformer oil properties using advanced multi attribute texture classification method

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Abstract-Electrical power systems play an important role in both manufacturing and services in both industrial and commercial sectors. Any energy transmission and distribution system is a major asset transformer. The transformer performance depends on the quality of the insulated oil. The traditional methods were the cost and time consuming. The proposed task uses a fast and reliable multi- attribute image processing technique to overcome all existing problems. In the proposed image processing analysis, the transformer oil images inputs are processed using quick software based analysis that determines the key features of the transformer oil processing it based on the multi-attribute structure image classification technique. Due to the changes color in the transformer oil, the oil properties also deteriorating. These factors and the transformer oil color are very close to each other. In this proposed method is found between the two intermittent entropy pattern and linear regression techniques. The performance of the proposed multi attribute texture classification method is validated through simulation, the simulation is created using Matlab2017a software. The transformer's work and health dependence is by using this multi-attribute texture classification system to find the basic quality of the transformer oil.

Key words: Entropy, texture, regression, Multi attribute classification, transformer, preprocessing and MATLAB.

1. Introduction

Transformer is a versatile device used at different points in the transmission and distribution substation. The main purpose of power or distribution transformer is the power transfer of one level of voltage to another level. These properties are modified by the aging process as the properties of the mineral oil properties used in the transformer are specific. Transformer's role is an integral part of the

power structure that is very important for a trusted power system. It should also be checked that the transmitter health is primarily based on the insulation type used. The different insulators used in the transformer used to make almost all alternators use as a material for the mineral oil. Thus transformer is very important to check the oil nuances from time to time to check health.

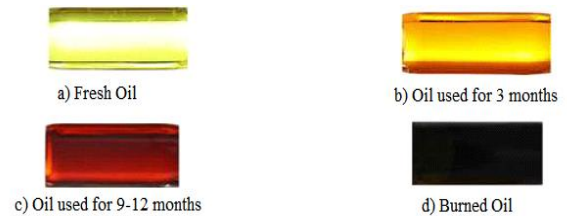


Figure 1. Images of transformer oil

Figure 1 shows the different properties of the transformer oil. There are a number of traditional methods available but these methods are expensive to take too long. This work transformer oil and thus provides a quick simple method to check the transformer health from a transformer oil sample image. Image processing technique involves the pre-processing of the image taken by the transformer oil used for the best character being removed using the adaptive median filter mechanism. These are based on the accepted oil sample degradation which is a randomly calculated statistical measurement using multi attribute classification.

This proposed method is mainly useful to detect the error occurring in the presence of a single gas. The acoustic image reduces the signal and the presence of any unnecessary signal that is removed by filters. The microscopic images have a lighter than the average resulting in the poor display of most of the pixels. A multi attribute texture classification method is a tool that can better resize the pixels

values so there is better to distinguish it from the pixel values and analyze it.

2. Research background

There are several methods to analyze the transformer oil and increase the life of transformer. In this section to discuss some of the existing work regards transformer oil investigation.

Thermal and optical diagnostic method gathers the source of information from an electromagnetic spectrum bandwidth up to 1016Hz between 104Hz. Thermal imaging cameras produce an infrared formula for image capture and temperature measurement. Thermal imaging easily identifies the bushings and tank [1-4] hot spots. The mechanical detection procedure [5] is explained in short circuit conditions due to the tone of the transformer. After the current power application, the volatile oil pressure is measured to determine the tension force. Tensions are unstable oil pressure.

An artificial neural network system and Diagnostic Gas Analysis (DGA) is used as an application to increase computational efficiency [7-8]. There is no hidden relationship between dissolved gases and split-off types and this can be recognized by the ANN method with the most effective training process. Once again, the spreading algorithm is only used in ANN method to detect errors in the transformer. Furthermore, alternators refer to the fault line, which aims to increase the DGA by using fuzzy logic [9-11]. There are three subsequent acts involved in the fuzzy logic analysis; they are Fuzzyfication, Fuzzy Interruption, and Defuzzyfication. Since the design of the transformer fault diagnostic system is uncertain, the fuzzy logic system is divided into two types of data mining to obtain the correct results [12].

DGA is a neural network and a fuzzy logic [13]. This method uses the [14-15] expert system and neural network to find fault. The author proposed the extension neural network to find the transformer big bug with the help of soluble gases. Self-Organizers Map (SOM) method detects the transformer fault; It is a data mining technology and self-reliance [16-17]. SOM algorithm and self-organizing layouts for networking techniques are used to detect real time error condition. The technique in SOM is done from

the modeling record DGA data [18-21]. This method removes uncertain and haziness, and it's better than all other faults to find fault. The above discussed all methods have some limitation against transformer oil investigation so in this work introduce multi attribute texture classification method to overcome the all limitations.

3. Materials and method

The proposed image processing-based transformer oil investigation diagram is shown in figure.2 and this proposed method has three stages, such as preprocessing, feature extraction and classification. Image processing technique involves pre-processing of the image taking the transformer oil used for the best character being removed using the adaptive median filter for better visibility. They are based on the accepted oil sample degradation, which is a randomly calculated statistical measurement feature. Thus the features of the data oil can be calculated using nonlinear regression method to predicted the oil properties and finally multi attribute classification method is classify the faults of transformer oils.

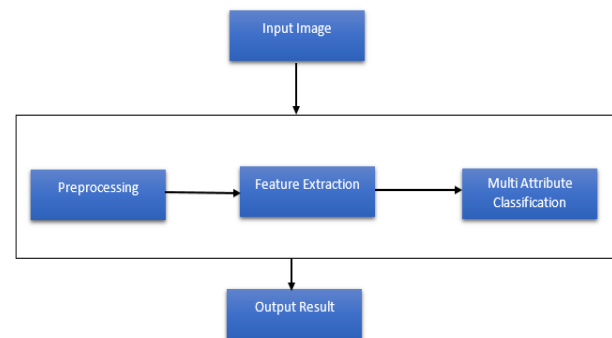


Figure 2. Block diagram of Transformer Oil investigation

3.1 Preprocessing Using Adaptive Median Filter

In the preprocessing stage the proposed adaptive median filter creates the grayscale values of the original transformer oil image. The gray scale values then generated with gray distribution in uniform are normally associated with gray value distribution. This step is done with efficient processing work image and carry this on the strategy with histogram map balance methods and the proposed method creates the histogram value of the

preprocessed image. The histogram value is rearranged to provide result image based on the effect of the balances. The resulting image will be shown to the user and will not be allowed to provide a new one. Based on the original size, the package process entered and the partitioning process will be entered to give a new decision. This method will remain in revisions until the user satisfies.

Algorithm steps of Adaptive median Filter

1. Start
2. Prepare appearance transformer oil information X_i
3. Read transformer oil's input image I .
4. Insert adaptive median algorithm for both primary input and output positioned data
5. Obtained the noise variance level V and weighted variance level δ .
6. Measure the nearest threshold optimal ranges from (0.3.-1.0) for all pixels
7. Accomplish the inverse operation of Adaptive median filter (AMF) $I = \text{AMF}(D_i)$

If X_i is greater in threshold value means

$$C_s = \sum(I + X_i).$$

End

8. Obtain the results based on wavelet Sustained features.

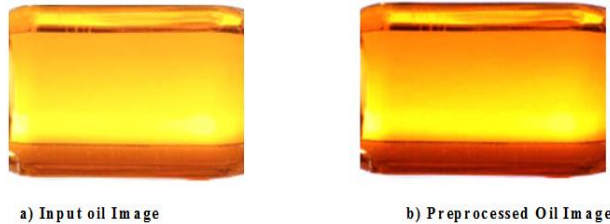


Figure 3. Result of Preprocessed oil image

Figure 3 shows the preprocessed result of proposed transformer oil investigation system, as compared with input image the preprocessed image is noise free.

3.2 Feature Extraction Using Collective Nonlinear Regression Method

The extracted features are selected based on the values of each pixel sequence in different areas. Collective Nonlinear regression (CNR) programmatic formats are created using the method for measure the similarity of each sequence. Calculates the function selected to determine the final technique that can be utilized for oil investigation after selecting the integral synchronization function area of each region with the image extracted.

Collective Nonlinear regression (CNR) Algorithm

Input: Extract the Features from Pre-processed Image using Collective Nonlinear

Regression method NRFv.

Output: Similarity measures of preprocessed image (SFv)

Start the Process

1. For each level l from preprocessed image
2. Measure the similarity features

$$SF = \int_{i=1}^l \int_{j=1}^{size(NR)} \sum NRFv(j, l) = Fv \quad (1)$$

Where l = level, i and j is the level, Fv = Vector Features

3. Reconstruct every pattern $SFv = \frac{NRFv}{size(NR)}$
4. Repeat the steps from 2 and 3
5. Stop.

The above discussion process calculates the synchronized convenience of each pixel and finally calculates the overall pixels similarity. Some of them have been described as 16 of the totally specifications by using collective nonlinear regression method and the flow chart of feature extraction is shown in Figure 4.

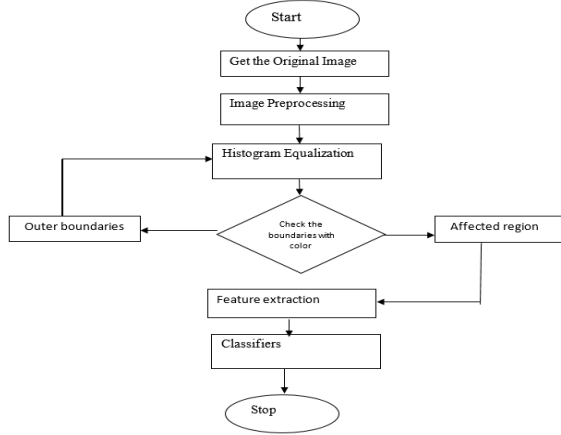


Figure.4 Flow Chart of Feature extraction
Entropy

The Feature of Entropy is used measures the constant values between pixels up to = [0, 1] and the following mathematical expression is used to calculate the entropy value.

$$\text{Entropy} = \sum_{i,j} p(i,j)^2 \quad (2)$$

Contrast

Contrast has been measure the several of luminance to take the object from ranges from = [0, 1] and the following mathematical expression is used to calculate the entropy value.

$$\text{contrast} = \sum_{i,j} |i - j|^2 p(i,j) \quad (3)$$

Correlation

Correlation has been used to measure of the relationship between the near pixels from the range between -1 to 1

$$\text{correlation} = \sum_{i,j} \frac{(i,j)p - \mu_x \mu_y}{\sigma_x \sigma_y} \quad (4)$$

3.3 Multi Attribute Texture Classification

Features and its classification can be tested with multi attribute texture classification method and can be used to find the corners in an image link. This algorithm comes with good corner statistics after the team. The statistics section is tested to find the corner in an image link. The performance of Multi attribute classification has validated using several parameters like precision, recall, accuracy and F-measure.

Precision: It is used to identify how much number of positive samples has been perfectly classified to the number of models in a class model

$$\text{precision} = \frac{Tp}{Tp + Fp} \quad (5)$$

Recall: It is also used to identify how much number of positive samples has been perfectly classified to the number of models in a class model

$$\text{Recall} = \frac{Tp}{Tp + Fn} \quad (6)$$

F-measure: It is used to identify how much number of negative samples has been classified to the number of models in a class model

$$F_{\text{measure}} = \frac{2 * \text{precision} * \text{recall}}{\text{precision} + \text{recall}} \quad (7)$$

Accuracy: The bottom of the equation is presented as follows the number of samples that are categorized correctly by the number of samples for advertisements.

$$\text{Accuracy} = (TP + TN) / (Tp + Tn + Fp + fn) \quad (8)$$

Algorithm:

Input: Transformer oil's image

Output: Type X

Variable Th.

Start

Area S= Perform light absorption method

Input image= Preprocessed using Adaptive median filter

X = multi attribute texture analysis.

If X <Th1> then

Normal oil

Else X <Th2> then

Used 6-9 month oil

Else if X <Thn> then

Burned oil

End

Stop.

The system classification using the Multi attribute texture classification technique to investigate the transformer oil properties. The

proposed classification is performed collective nonlinear regression vector technique. In this method captures the image of the preprocess and feature extraction after the first region-based system makes picture prediction. Then this process calculates the classification method to classify the result given.

4. Results and discussion

In this exploration work have utilized a Multi attribute texture classification Algorithm to investigate the transformer oils to improve the life of transformer. The performance of proposed Multi attribute texture classification based transformer oil investigation has been validated through simulation using Matlab software and the GUI screen of the proposed system is shown in figure.5

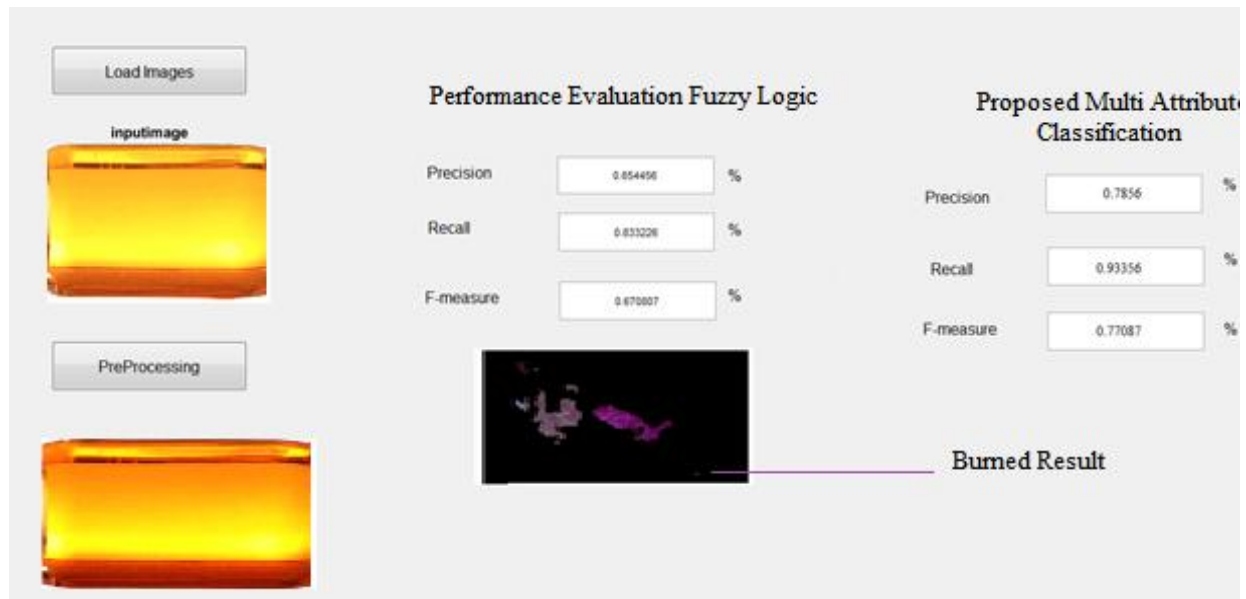


Figure 5. Simulation GUI screen

The performance of proposed Multi attribute texture classification based transformer oil investigation has been validated through simulation using Matlab software and the GUI screen of the proposed system is shown in figure.5 and the following tables and figures are disc the performance evaluation of proposed system.

Table 1. Feature extraction result of Normal oil image

Sample no	1	2	3	4
Mean	71.03	54.07	64.3	62.7
Standard deviation	99.7	94.8	91.5	96.01
Variance	46.6	65.4	70.49	47.74

Skewness	0.78	1.23	1.01	1.05
Entropy	4.25	3.26	4.12	4.112

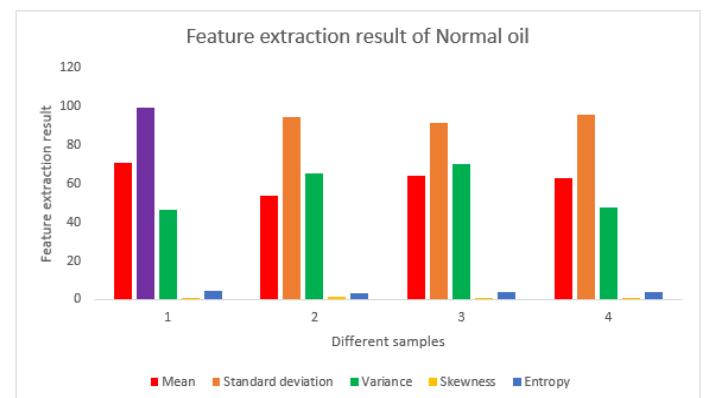


Figure 6. Feature extraction result of Normal oil image

The table 1 and figure 6 discuss the performance evaluation of normal transformer oil with different features such as entropy, mean, standard deviation, variance and skewness. The proposed collective nonlinear regression method is perfectly extracted all texture features from normal oil images with 5 samples.

Table 2. Feature extraction result of Burned oil image

Sample no.	1	2	3	4
Mean	49.3	31.04	27.752	30.11
Standard deviation	90.3	70.87	69.09	69.35
Variance	50.11	40.33	31.26	26.51
Skewness	1.38	2.21	2.31	2.2398
Entropy	3.11	2.31	2.27	2.79

The table 2 and figure 7 discuss the performance evaluation of Burned oil image with different features such as entropy, mean, standard deviation, variance and skewness. The proposed collective nonlinear regression method is perfectly extracted all texture features from burned oil images with 5 samples.

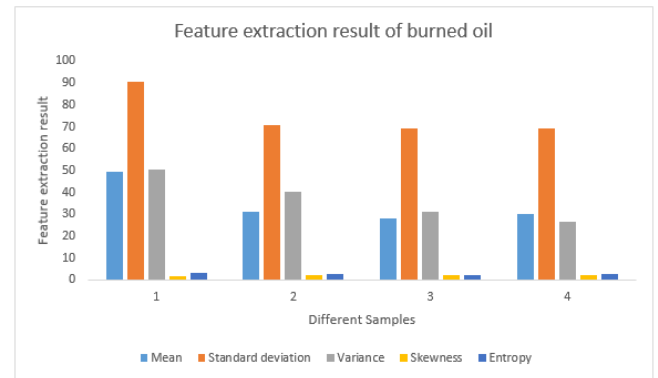


Figure.7.Feature extraction result of Burned oil image

Table 3: Performance analysis of Classification

Methods	Recall (%)	Precision (%)	Accuracy	F measure (%)
Multi attribute texture classification	91.36	88.9	98.63	4.32
Multi attribute texture classification	89.02	78.2	91.20	9.20
Fuzzy Logic	86.30	74.3	85.69	15.03

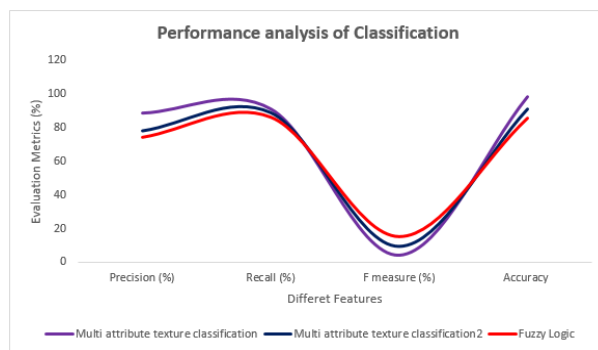


Figure 8. Performance analysis classification

Table 3 and Figure 8 demonstrates the F-measure, recall, and precision come about utilizing the different element spaces. The accuracy of different transformer oil Feature Extractions is extraordinarily identical in real time situation. The experimental results has been justify that the essential point here has been the preparing time, which has documented to histogram includes as it is insignificant complex than other conventional methods. As compared with fuzzy and artificial neural network methods the proposed multi attribute

texture classification method achieve the best result against all working conditions.

5. Conclusion

The proposed transformer oil analysis Image processing technique is a reliable and user-friendly software-based analysis technique. An Adaptive Median filter is used to filter out salt and pepper noise. Collective nonlinear regression technique is used to detect the different oil properties of the transformer function, such as the exponent, power factor, at the NN. The Collective nonlinear regression based on the accepted oil sample degradation, which is a randomly calculated statistical measurement feature. Thus the features of the data oil can be calculated using nonlinear regression method to predict the oil properties. The proposed multi attribute texture classification algorithm mechanism successfully classifies good or poor oil based on oil properties. Furthermore, percentage degradation and life oil model are further calculated. Therefore, this work provides a simple and fast way to check the transformer health from the transformer oil image.

REFERENCES

- [1] Sidram,M,H. and Hegde,S,“A Novel Approach of Transformer Oil Quality Analysis Using Image Processing”,IOSR Journal of Computer Science (IOSR-JCE), 2014.
- [2] IEEE Loading Guide for Mineral Oil Immersed Transformer, C57.91, pp. 18–19, 46–53, 1995.
- [3] J. Oliver: “Estimation of transformer winding temperatures and coolant flows using general network method”, IEE Proc., Vol. 127, No. 6, 2017.
- [4] M. K. Pradhan and T. S. Ramu, “Prediction of Hottest Spot Temperature (HST) in Power and Station Transformers”, IEEE Transaction on power delivery, Vol.18, No.4, 2003.
- [5] Endah Yuliasuti, “Analysis of dielectric properties comparison between mineral oil and synthetic ester oil”, Delft University of Technology, Netherland, June 2010.
- [6] Dr. J Spencer, “Optical detection of the degradation of transformer oil”, University of Liverpool, 2009.
- [7] Sherif S. M. Ghoneim, Sayed A., Taif ,”Dissolved gas analysis as a diagnostic tool for early detection of transformer faults”, Advances in Electrical Engineering Systems, Vol.1, No.3, pp.152 – 156, 2012.
- [8] G. J. Pukel, H. M. Muhr, W. Lick, “Transformer diagnostics: Common used and new methods”, Graz University of Technology Austria.
- [9] Naveen Kumar Sharma, Prashant Kumar Tiwari, and Yog Raj Sood, “Review of Artificial Intelligence Techniques Application to Dissolved Gas Analysis on Power Transformer”, International Journal of Computer and Electrical, Engineering, Vol.3, No.4, pp.577- 581, 2011.
- [10] Amritpal Singh, and P. Verma, “A Review of Intelligent Diagnostic Methods for Condition Assessment of Insulation System in Power Transformers”, IEEE International Conference on Condition monitoring and Diagnosis, Beijing, China, 2008.
- [11] W. Xu, D. Wang, Z. Zhou and H. Chen, “Fault Diagnosis of Power Transformers: Application of Fuzzy Set Theory”, Expert Systems, and Artificial Neural Networks, IEEE Proceedings of Science, Measurement and Technology, Vol.144, No.1, pp. 39-44, 1997.
- [12] M.H. Wang, “Extension neural network for power transformer incipient fault diagnosis”, Generation, Transmission and Distribution, IEEE Proceedings 2003, Vol.150, No.6, pp.679 – 685, 2003.
- [13] Teo. Brescia, Sergio. Bruno, La Scala Massimo, Silvia Lamonaca, Giuseppe Rotondo, and UgoStecchi, “A fuzzy-logic approach to preventive maintenance of critical power transformer”, Electricity Distribution, 20th International Conference and Exhibition , pp. 1 – 5,2009.
- [14] Rahul Soni, KaushalChaudhari, “An Approach to Diagnose Incipient Faults of Power Transformer Using Dissolved Gas Analysis of Mineral Oil by Ratio Methods Using Fuzzy Logic”, (SCOPES)-2016.
- [15] K. Tomsovic, M. Tapper, and T. Ingvarsson, “A fuzzy information approach to integrating different transformer diagnostic methods,” IEEE Transactions on Power Delivery, Vol. 8, No. 3, pp. 1638–1646, Jul. 2017.
- [16] CE lin, J M ling. “An Expert System for Transformer Fault Diagnosis Using Dissolved

Gas Analysis,” IEEE Trans on Power Delivery, vol. 8, pp.231-238, Jun. 2013.

- [17] CS Chang, CW Lim, and Q Su, “ Fuzzy-Neural approach for Dissolved Gas Analysis of Power Transformer Incipient Faults,” in Australasian Universities Power Engineering Conference (AUPEC 2004), pp.26-29 September 2004, Brisbane, Australia.
- [18] Hongzhong Ma, Zheng Li, P.Ju, Jingdong Han, and Limin Zhang, “Diagnosis of Power Transformer Faults Based on Fuzzy Three-Ratio Method,” in The 7th International Power Engineering Conference, IPEC 2005, Nov 2005.
- [19] Ma Weiping, "The Influence of Microorganism on the tan60f Large Power Transformer Oil," Jilin Electric Power Technique, Vol. 1,2001,
- [20] Ma Weiping, Cheng Fangxiao, Sun Ying, Xie Chungui, Ao Ming" Fault Diagnosis On Power Transformers Using Nonelectric Method" IEEE International Conference on Power System Technology 2006.