SUPERVISED MACHINE LEARNING ALGORITHM USED TO DETECT FAULT IN AN INDUCTION MOTOR

Kulle Madhuri[1], Dr Kavitha K S[2], Dr VK Agrawal[3]

[1]PG Student, Department of computer science and Engineering, GAT, Bengaluru, Karnataka, India
[2]Professor, Department of computer science and Engineering, GAT, Bengaluru, Karnataka, India
[3]Professor, Department of information science and Engineering, PES, Bengaluru, Karnataka, India

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Abstract - *The objectives of this paper is to expand a SVM primarily based induction motor outside faults identifier and study its overall performance with actual-time induction motor faults records. Radial Bases characteristic kernel is used to teach and check the SVM, even though the impact of other Kernel functions became also studied. The proposed SVM technique uses RMS values of three-phase voltages and currents as inputs. The checking out results showed the efficacy of the SVM primarily based technique for identifying the external faults skilled by way of three-section induction automobiles.*

.*Key Words***: AI, ANN, SVM**

1.INTRODUCTION

This report is template. The induction motor is one of the maximum crucial vehicles used in commercial applications[13]. Its low price and high overall performance in addition to its reliability make them the most famous alternating modern-day cars used within the business and commercial fields. Reliability should be of excessive preferred in these applications. Induction vehicles are the mainstay for every enterprise. but like another device, they will ultimately fail due to heavy duty cycles, poor operating environment, set up and production factors, and many others. With escalating needs for reliability and performance, the sector of fault diagnosis in induction motors is gaining importance. If the faults aren't prognosticated in advance, it can result in big revenue losses as well as pose chance to reliability and safety of operation. Detection of those faults in advance enables the upkeep engineers to take the important corrective actions as speedy as viable. less difficult strategies are had to allow even amateurish operators with nominal understanding of the device to test the fault condition and make dependable choices.

The occurance of fault may be internal and external fault in an induction motor. The history of fault monitoring and fault isolation began with the usage of electromechanical relays to defend the motor towards faults[12]. but, these electromechanical relays are gradual in operation, eat sizeable strength, and require periodic maintenance because of mechanical elements worried. The creation of semiconductor technology had a high quality effect at the induction motor safety field, and replaced the electromechanical relays with the aid of stable kingdom relays as their running speed is faster, devour less strength, less expensive to manufacture and provide more reliability.

The structures based totally on artificial Intelligence (AI) techniques take the area of the human experts by way of offering with the required statistics about the device performance. these AI strategies encompass expert systems, synthetic Neural Networks and others. This paper will use a new AI method known as support Vector Machines (SVM) that is proven to offer higher performance in some applications. The schooling technique in SVM is more green than ANN[15]. Statistical mastering principle paperwork the spine of SVM approach. The method attempts to increase a more reliable classification gadget which could educate faster. SVM could be implemented to become aware of outside fault situations in a three-segment induction motor. it is going to be educated with fault modern and voltage signals acquired from a real induction motor and the efficacy of the technique may be tested[4].

The goal of this examine paper is to check using SVM method for sample reputation applications and check out the impact of various parameters at the training and testing of the method and to recognize the use of Libsvm software program application for sample recognition programs. also, apprehend the traits of external faults on three-segment induction vehicles and practice the SVM method for figuring out external faults in 3-segment induction motors.

1.1 Machine Learning Technique

The idea of AI came from the notation of implementing the human's intelligence in a machine, so it may carry out the equal form of functions that capabilities human thinking processes. AI composed of numerous branches which includes expert structures (ES), genetic algorithms (gasoline), fuzzy good judgment (FL), problem solving and making plans (PSP), common sense programming (LP), ANN, SVM, and more branches. those techniques have the capability to deal with nonlinear issues and to address big

quantity of records; as soon as they're trained they are able to produce a model for the prediction of the brand new information. The AI techniques were applied in many disciplines which include engineering, economics, medication, and navy. This paper uses SVM as an AI approach for type and prediction of external faults experienced by three-segment induction motor. It also compares the performance of SVM with ANN for fault identity. within the following sections, ANN and SVM strategies are described in short from the existing literature.

1.2 Artificial Neural Network

ANN is a computational version used in computer technological know-how and different research disciplines, that is based totally on a huge collection of easy neural devices[6].It emulates the biological neural networks right into a mathematical model. it's been utilized by many researchers in different medical fields to remedy specific varieties of troubles together with sample recognition, prediction, and optimization. ANNs are parallel computing systems including a number of easy processors with many interconnections. practically, this approach allows the community to research regulations for solving a problem through processing a hard and fast of examples. these easy processors are together interconnected with weights assigned to the connections. by way of enhancing those weights consistent with mastering guidelines, the ANN may be skilled to apprehend any pattern given by using the education facts.

using ANN for pattern popularity includes two steps: first, the network is educated to learn the patterns the use of the training statistics; 2d, the trained network is used to check and monitor. in the ANN the neuron is the processor unit in the community, and these neurons are connected together in layers. Inputs are obtained at the first layer and they're processed inside the neuron. those technique steps consist of the multiplication of the inputs through their weights and including them together, and then transfer them into the translation a part of the neuron as shown in figure 1.
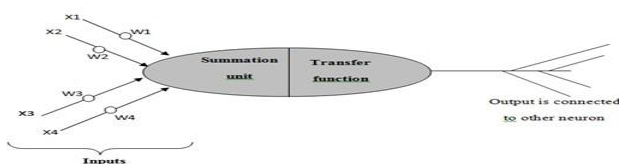

Fig -1: Single Neuron.

once the neuron transferred within the translation part, the incoming weighted sign will be sent thru the transfer characteristic. there are numerous switch capabilities proposed together with tanh and sigmoid. After that the output from the input layer is transferred to hidden layers, one output from every neuron will range from other outputs via the link weights. commonly one hidden layer is utilized in a network as proven in figure 2.
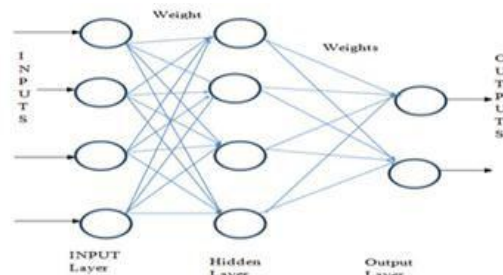

Fig -2: Neural Network.

1.3 Support Vector Machine :

Support vector machines (SVMs) are a set of supervised getting to know used for classification, regression and outliers detection. The idea in the back of SVM is that the device learns from the schooling statistics to classify the input facts into one-of-a-kind instructions. If information isn't always linearly separable, it's far mapped into a characteristic space where the training records is separable. The classifier is a hyperplane, so the most important points are the factors which define the hyperplane, which might be called support vectors as shown in figure 3. The SVM approach requires the answer of an optimization problem to locate this hyperplane.

The properties of SVM make it a treasured technique in class, due to the fact it may cope with very massive feature spaces. The schooling is performed so that the dimension of categorized vectors does now not have a unique have an effect on at the overall performance of SVM as it has on the performance of the traditional classifier. therefore, it is very efficient for massive type problems specially in strength structures, due to the fact the range of characteristic to be classified may be
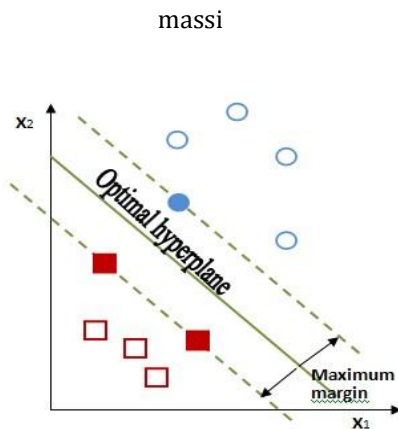
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Fig.3 Different Type of classes using SVM

2. IMPLEMENTATION

The SVM method is based on mapping the input information into better dimensional area and finding the most suitable hyperplane that separates the input information with maximal margin if it is not linearly separable. The support vectors are those with nearest training patterns from the hyperplane (Richard et.al, 2001). The mapping of the records into better dimensional area can be achieved via one of the four Kernel features. The linearly separable case is explained below first, after which the mapping the use of Kernel functions for nonlinear separable cases are explained.

the primary case considered has the training facts in handiest two lessons and are linearly separated as shown in figure four. The training set is given by way of Equation (1) underneath:

$$(X_1, y_1) \dots (X_n, y_n), X_i \in R^n \qquad (1)$$

$$y_i \in \{-1, +1\}$$

The separating hyper plane can be expressed by Equation (2) below:

$$W^TX + b = 0, \qquad (2)$$

where W is the weight vector, which is perpendicular to the hyperplane, "b" is the bias that expands the margin.
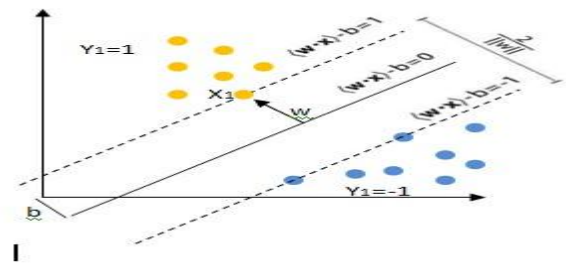

Fig.4 SVM Technique

Precision of the training data relies upon on the most beneficial separating hyperplane that separates the records through maximizing the margin 2/||w||. This trouble can be solved via quadratic optimization approach as formulated and said below:

$$y_i(W^TX_i + b) \geq 1 - \xi_i, \ \xi_i \geq 0, \ 1 \leq i \leq n,$$

Where, ξ_i are the slack variables, which measure the miscalculation of the data $X_{i,c}$ is the error penalty constant.

The second one case takes place while the educated statistics are past the boundary of the linear separation. Nonlinear class needs to be implemented by mapping the data into function space using Kernel function. there are many Kernel functions used which include

1. Linear: $K(x_i, x_j) = x_i^T x_j$

2. Polynomial: $K(x_i, x_j) = (\gamma.x_iTx_j+r)d, \gamma > 0$

3. Radial Basis Function: $K(X_i, X_j) = \exp(-\gamma||X_i-X_j||2), \gamma > 0.$

4. Sigmoid: $K(X_i, X_j) = \tanh(\gamma.X_i^TX_j+r),$

where r, d, γ are Kernel parameters.

1.1 Analysis

The training of the SVM was accomplished using Radial Bases function as the Kernel. The trying out changed into performed by means of the usage of the 21 trying out samples. The optimization of the Kernel parameters changed into completed using grid search of the Libsvm. exclusive scaling factors for the information were also used within the training manner. the first case taken into consideration changed into applying RBF Kernel with a scaling range among (-1, 1). After trying to find the great parameters values for γ and c using grid.py, the most desirable values obtained were (C=128, γ =0.5). the search

outcomes are shown in parent five. The category accuracy obtained for these parameter values changed into 90.47% (19/21 samples) as proven in figure 6.
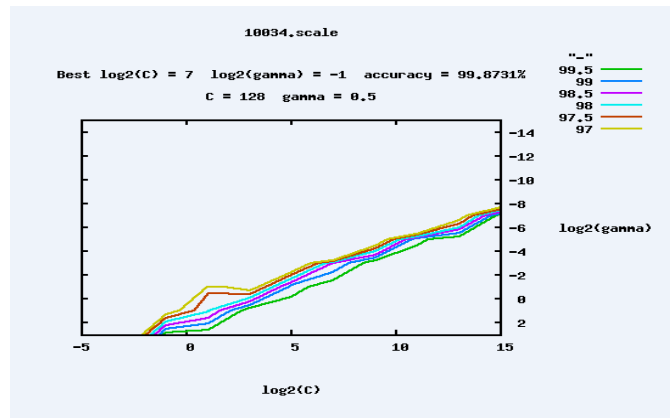

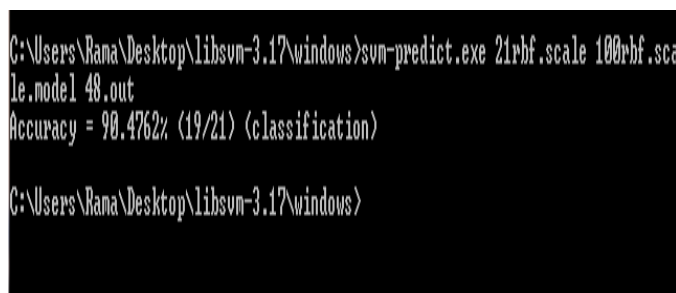**Fig.5** Grid.py of Optimum C and γ for (-1,1) Scaling.

Fig.6 Screen-shot of Prediction Command for 21 Test Cases Scaling (-1, 1).

for the reason that classification accuracy is not 100% with this scaling, a second case changed into taken into consideration the usage of the identical Kernel characteristic with a exclusive scaling range between (-1, zero). For this example, the most desirable Kernel parameters were discovered to be (C=512, γ =0.5).
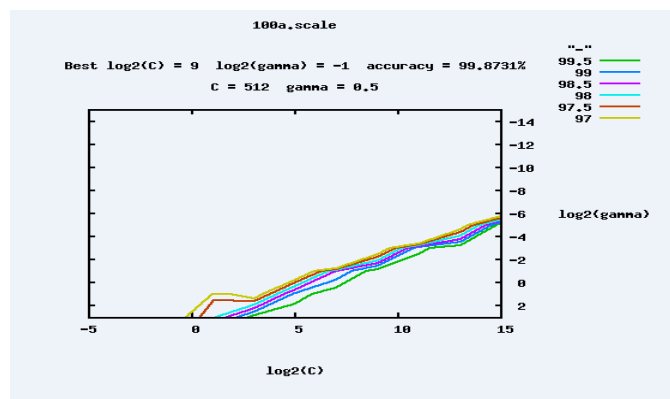

Fig.7 Grid.py of Optimum C and γ for (-1,0) Scaling.
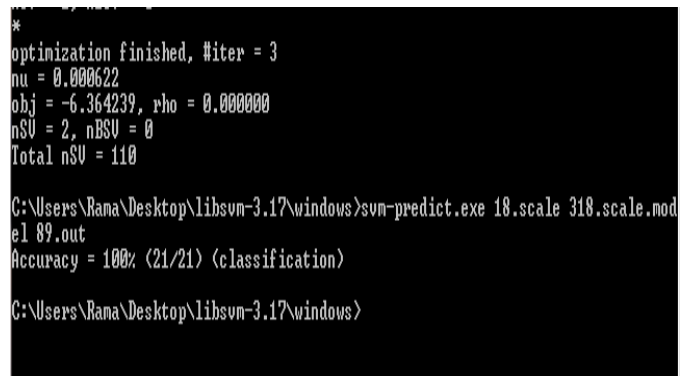

Fig.8 Screen-shot of Prediction Command for 21 Test Cases.

the search results are proven in figure 7. The category accuracy (trying out) became determined to be one hundred% for the 21 samples.   The screen-shot of the execution of Libsvm for this situation is shown in figure 8.

In SVM technique, model creation through acquiring support vectors uses a nicely-developed software device in Libsvm that does not require trial and errors approach. To select γ and C parameters inside the SVM approach, Libsvm has a well-developed software program tool the use of the grid search. A RBF Kernel is used in this project for growing the educated version; also different Kernel functions are brought on this assignment to study their effectiveness on the checking out accuracy. it's miles discovered that the scaling range has an impact at the prediction accuracy for a few Kernel capabilities in the SVM based totally induction motor faults identification technique taken into consideration in this look at. one of the testing cases considered used a part of the statistics for developing the version and the remaining element for trying out the accuracy of the prediction.

3. CONCLUSIONS

The objective of this study is to develop a SVM based induction motor outside faults identifier. The real time accumulated statistics from a 1/3 hp, 208 V three-segment squirrel cage induction motor is used to train and test the SVM. Libsvm software program application is used for implementing the SVM technique. further, the Libsvm tools library is used for looking the most reliable parameters for reaching the good enough accuracy.SVM has the benefits of simplicity of creating the version and testing its accuracy. The time ate up for the model introduction section with SVM approach is less than the ANN approach, and SVM approach accuracy is higher than ANN based method.

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