International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 12 | Dec 2018 www.irjet.net p-ISSN: 2395-0072

A Review on SVM Based Induction Motor

Vandana Dewangan[1], Varsha Sharma[2]

[1,2]Dept. of Electrical Engineering, RSR Rungta College of Engineering, Durg, C.G., India

---

Abstract - Induction machines play a crucial role in certain industries, such as manufacture, transportation, etc. They offer the core capabilities for industrial success and the maintenance of them is essential and profitable to most electrical industrial processes. A lack of coherent maintenance strategy may lead to the loss of individual items of a plant, and a heavy capitalized losses burden. As it is not economical to introduce redundant backup machines, online monitoring for induction machines is important for safe operation and production quality. In order to keep machines in good condition, techniques such as fault monitoring, detection, classification, and diagnosis have become increasingly essential. There are invasive and noninvasive methods for machine fault detection. The noninvasive methods are more preferable than the invasive methods because they are based on easily accessible and inexpensive measurements to diagnose the machine conditions without disintegrating the machine structure. Recently, artificial intelligence (AI) techniques have been proposed for the noninvasive machine fault detection. They have several advantages over the traditional model -based techniques [6], [9]. They require no detailed analysis of the different kinds of faults or modeling of the system. These AI-based techniques include expert systems, neural network, and fuzzy logic. An expert system is able to manage knowledge-based production rules that model the physical system. Neural network approaches can be considered as "black-box" methods as they do not provide heuristic reasoning about the fault detection process. Fuzzy logic systems can heuristically implement fault detection principles and heuristically interpret and analyze their results. In this paper, neural network type approach is used because generalized feed forward neural network (GFFDNN) is able to provide an accurate fault diagnostic classification.

Keywords- Induction motor, Fault detection, Neural Network

Literature Survey

Aydin et al. (2008) The use of induction motors is widespread in industry. Many researchers have studied the condition monitoring and detecting the faults of induction motors at an early stage. Early detection of motor faults results in fast unscheduled maintenance. In this study, a new artificial immune based support vector machine algorithm is proposed for fault diagnosis of induction motors. Support vector machines (SVMs) have become one of the most popular classification methods in soft computing, recently. However, classification accuracy depends on kernel and penalty parameters. Artificial immune system has abilities of learning, memory and self adaptive control. The kernel and penalizes parameters of support vector machine are tuned using artificial immune system. The training data of support vector machine are extracted from three phase motor current. The new feature vector is constructed based on park's vector approach. The phase space of this feature vector is constructed using nonlinear time series analysis. Broken rotor bar and stator short circuit faults are classified in combined phase space using support vector machines. The experimental data are taken from a three phase induction motor. One, two and three broken rotor bar faults and 10% short circuit of stator faults are detected successfully.

DIAN R. SAWITRI et al. (2012) Fault in induction motor is crucial problem in industrial processes. This paper presents the system for electrical fault detection in induction motor fed by inverter. Current spectrum with different frequency is used to fault monitoring. Faults observed includes variation of frequency, unbalance voltage, and inter turn short circuits. Through an experiment, the fault was fired and the current spectrum recorded at steady state condition. Preprocessing is performed before the identification process. It includes noise reduction using wavelet analysis and feature extraction with Principal Component Analysis (PCA). Both processes are intended to eliminate the noise, reducing the dimension of feature, and retrieve components of the optimal features for classification. Strength of identification capability using Support Vector Machine (SVM)

is 83.51%. Based on the ROC (Receiver Operating Characteristic) analysis, the SVM classifier has a good enough performance. This is indicated by the sensitivity is 74.31%, specificity is 47.30% and G-Mean is 1.1028.

Chalermchat Manop (2010) This paper presents a new technique for diagnosis of stator winding shorted turns in three phase induction motors using support vector machine (SVM) as a classifier in conjunction with a voltage signature analysis as feature extraction. The proposed dq0 voltage components related to three phase voltages are obtained by using Park's transformation. Unlike general dq0 quantity, the required dq components are considered from only harmonics in a certain range resulted from the stator shorted turn fault whilst the required zero component is determined from the fundamental voltage excitation only. The procedure for finding the harmonic spectrum associated with the stator fault employs a FFT technique together with digital signal processing in order to enlarge such harmonics to be easily detected. The data of d, q and zero components will be used as the input features for a SVM classification and diagnosis. In order to confirm that the dq0 voltage components could be used as quantity for identifying the stator fault, patterns of dq0 voltage components in three-dimension are plotted. The obtained trajectories are obviously different depending on the severity of the shorted turn fault. In training and testing with a multiclass-SVM classification, the good accuracy is obtained under various load conditions for both healthy and stator fault conditions. The SVM classification performance of the proposed method has high accuracy greater than 98% comparable to other feature extraction processes such as a motor current signature method (MCSA) but the number of training data and features for the proposed technique are less.

Samira Ben Salem et al. (2012) In this work we propose the air-gap torque as failure signature to detect mechanical faults in particular the eccentricity. In this way, we compare the proposed signature with those most used recently in particular the current space vector (Park vector) and complex apparent power. This signature is subsequently analysed using the classical fast Fourier transform (FFT). The magnitudes of spectral components relative to the studied fault are extracted in order to develop the input vector necessary for the pattern recognition tool based on support vector machine (SVM) approach with an aim of classifying automatically the various states of the induction motor.

V.N.Ghate (2009) Industrial motors are subject to various faults which, if unnoticed, can lead to motor failure. The necessity of incipient fault detection can be justified by safety and economical reasons. The technology of artificial neural networks has been successfully used to solve the motor fault detection problem. This paper develops inexpensive, reliable, and noninvasive NN based fault detection scheme for small and medium sized induction motors. Detailed design procedure for achieving the optimal NN model and Principal Component Analysis for dimensionality reduction is proposed. Overall thirteen statistical parameters are used as feature space to achieve the desired classification. Generalized Feed Forward (GFFDNN) and Support Vector Machine (SVM) NN models are designed and verified for optimal performance in fault identification on experimental data set of custom designed 2 HP, three phase 50 Hz induction motor.

Abdelkarim AMMAR (2017) This paper presents different enhancement techniques of basic direct torque control strategy for induction motor drive. It is well-known that the conventional DTC suffers from high torque ripples and variable switching frequency due to utilizing hysteresis comparators and lookup switching table. In this paper two improved techniques are presented. The first one deal with the use of an extended switching table which divides the flux locus into twelve sectors instead of six in order to solve control ambiguity and reduce ripples. The second technique bases on replacing the switching table by space vector modulation in order to maintain a fixed switching frequency and to minimize consequently the high torque and flux ripples. The effectiveness of the presented algorithms is investigated by an experimental implementation with the aid of real-time interface (RTI) based on dSpace 1104 bored.

M. V. Ramesh et al. (2011) This paper presents the fuzzy, PI controller for speed control of BLDC motor. The controller uses three fuzzy logic controllers and three PI controllers. The output of the PI controllers is summed and is given as the input to the current controller. The current controller uses P controller. The mathematical modeling of BLDC motor is also presented. The BLDC motor is fed from the inverter where the rotor position and current controller is the input. The fuzzy logic control is

learned continuously and gradually becomes the main effective control. The Simulink software was used to simulate the proposed scheme. The results are obtained for variable load torque.

Dr. Raaed Faleh Hassan et al. (2016) -Direct torque control (DTC) is one of the most important control techniques used in induction motor drives to obtain fast response torque control and high speed response. However, the classical DTC-SVM has disadvantage through transient, steady state and low speed. One of the most important defects is a high torque ripple and harmonics in stator current. In this paper, the proposed control system for solve these problems by utilizing space vector modulation upon the reference torque and flux (DTC-SVM). In this paper, the proposed technique, Proportional-Integral flux and Proportional-Integral torque controlling were designed to investigation calculated flux and torque with fast response and there is no steady state error. In addition, design Proportional-Integral flux and Proportional-Integral torque controller are utilized to improve voltage in d-q axis which feeding SVM. The DTC-SVM is pulse switching of the three-phase three-level neutral point clamped diode inverter (NPC) which fed the induction motor. This paper confirms using the Space Vector Pulse Width Modulation (SVPWM) technique for derivation of switching states. The proposed control is implemented using MATLAB/Simulink software package. Resulting tests which obtain from the new technique is better than the classical technique.

Ahriche Aimad et al. (2014) This paper presents a robust and speed-sensorless stator flux estimation for induction motor direct torque control. The proposed observer is based on sliding mode approach. Stator electrical equations are used in the rotor orientation reference frame to eliminate the observer dependence on rotor speed. Lyapunov's concept for systems stability is adopted to confine the observer gain. Furthermore, the sensitivity of the observer to parameter mismatch is recovered with an adaptation technique. The nonlinearities of the pulse width modulation voltage source inverter are estimated and compensated to enhance stability at low speeds. Therefore, a new method based on the model reference adaptive system is proposed. Simulation and experimental results are shown to verify the feasibility and effectiveness of the proposed algorithms.

SALIM et al. (2015) This paper presents an implementation of self-tuned PID controller (FPID) for speed control of DC motor based on LabVIEW (Laboratory Virtual Instrument Engineering Workbench Environment). The algorithms of fuzzy PID controller (FPID) and conventional PID controller (CPID) are implemented using PID and Fuzzy Logic simulation toolkits of the Lab View environment. The simulation results demonstrate that the designed self-tuned PID controller realize a perfect speed tracking with lesser rise time and settling time, minimum steady state error and give better performance compared to conventional PID controller.

Md. Habibullah et al. (2011) —Direct Torque Control (DTC) is widely used for ac drives. Attempts to combine DTC with Space Vector Modulation (SVM) have led to new ways. A new approach to DTC-SVM is presented in this paper. A Correlated Real Time Recurrent Learning (CRTRL) algorithm based Recurrent Neural Network (RNN) is used to estimate stator and rotor flux. Through measurement of the phase flux linkages and phase currents the RNN is able to estimate the rotor position, thereby facilitating elimination of the rotor position sensor. Fast dynamic speed response is obtained through maintaining the rotor flux constant as in the case of field orientation control. The control method proposed in this paper can reduce the torque, stator current, and rotor flux ripples which improve the system dynamic performance and robustness in different operating conditions. The proposed controller is also computationally efficient. The control methodologies and simulation results are given and discussed.

Amor BOUREK et al. The Direct Torque Control (DTC) was presented in the middle of the 80s. This strategy was an alternative to the field oriented control (FOC). It bases on the direct selecting of the switching states to control the voltage source inverter (VSI) through a switching look-up table [1].DTC offers more advantages compared to FOC like: simpler scheme, faster response and less dependence to machine parameters. The control of stator flux and torque is done by hysteresis controllers which choose the input voltage vector according to flux and torque errors. This paper concerns on a comprehensive

comparative study between two modified DTC strategies using twelve sectors switching table and fixed switching frequency through the space vector modulation. Subsequently, the presented methods will be investigated by real-time implementation. Our control system is implemented by dSpace DS1104 signal card. This board operates with MATLAB/Simulink platform basing on TMS320F240 DSP processor.

Conclusion

SVMs can produce accurate and robust classification results on a sound theoretical basis, even when input data are non-monotone and non-linearly separable. So they can help to evaluate more relevant information in a convenient way. Since they linearize data on an implicit basis by means of kernel transformation, the accuracy of results does not rely on the quality of human expertise judgement for the optimal choice of the linearization function of non-linear input data. SVMs operate locally, so they are able to reflect in their score the features of single companies, comparing their input variables with the ones of companies in the training sample showing similar constellations of financial ratios. Although SVMs do not deliver a parametric score function, its local linear approximation can offer an important support for recognising the mechanisms linking different financial ratios with the final score of a company. For these reasons SVMs are regarded as a useful tool for effectively complementing the information gained from classical linear classification techniques.

References

1. Aydin M. Karakose ,E. Akin, "SUPPORT VECTOR MACHINE BASED CLASSIFICATION IN CONDITION MONITORING OF INDUCTION MOTORS" 2007 International Aegean Conference on Electrical Machines and Power Electronics, 02 May 2008, 10.1109/ACEMP.2007.4510505, IEEE.
2. 1,2DIAN R. SAWITRI, 1I. KETUT E. PURNAMA, 1MOCHAMAD ASHAR "DETECTION OF ELECTRICAL FAULTS IN INDUCTION MOTOR FED BY INVERTER USING SUPPORT VECTOR MACHINE AND RECEIVER OPERATING CHARACTERISTIC" Journal of Theoretical and Applied Information Technology 15 June 2012. Vol. 40 No.1.
3. Chalermchat Manop1, Vijit Kinnares1 and Suphot Chunwiphat2, "SVM-BASED STATOR FAULT DIAGNOSIS FOR INDUCTION MOTORS USING DQ0 VOLTAGE COMPONENTS", International Journal of Innovative Computing, Information and Control ICIC International c
2010 ISSN 1349-4198Volume 6, Number 10, October 2010 pp. 4539–4553
4. Samira Ben Salem, Khmais Bacha and Abdelkader Chaari, "Support Vector Machine-based Decision for Induction Motor Fault Diagnosis using Air-Gap Torque Frequency Response", International Journal of Computer Applications (0975 – 8887) Volume 38– No.5, January 2012
5. V. N. Ghate, S. V. Dudul "Induction Machine Fault Detection Using Support Vector Machine Based Classifier" WSEAS TRANSACTIONS on SYSTEMS, Issue 5, Volume 8, May 2009.
6. Md. Habibullah, Md. Jahirul Islam, Md. Abdur Rafiq, Kalyan Kumar Halder, and B. C. Ghosh, "A New DTC-SVM Based Control of Field Oriented Position Sensorless Induction Motor Drive with Reduced Torque and Flux Ripple", International Journal of Computer and Electrical Engineering, Vol. 3, No. 3, June 2011.
7. SALIM, JYOTI OHRI, "FUZZY Based PID Controller for Speed Control of D.C. Motor Using LabVIEW", WSEAS TRANSACTIONS on SYSTEMS and CONTROL, Volume 10, 2015.
8. Ahriche Aimad†, Kidouche Madjid*, and Saad Mekhilef, "Robust Sensorless Sliding Mode Flux Observer for DTC-SVM-based Drive with Inverter Nonlinearity Compensation", Journal of Power Electronics, Vol. 14, No. 1, pp. 125-134, January 2014.
9. Jos´e L. Azcue P.∗, Ernesto Ruppert, "THREE-PHASE INDUCTION MOTOR DTC-SVM SCHEME WITH SELF-TUNING PI-TYPE FUZZY CONTROLLER",
10. 1Dr. Raaed Faleh Hassan, 2Mahmood Sawadi Rahi, "High Performance of Induction Motor Based on New DTC-SVM", International Journal of Scientific & Engineering Research, Volume 7, Issue 11, November-2016.
11. Sanna Pöyhöne, "SUPPORT VECTOR MACHINE BASED CLASSIFICATION IN CONDITION MONITORING OF INDUCTION MOTORS", June, 2004.
12. M. V. Ramesh1, J. Amarnath2, S. Kamakshaiah3 and G. S. Rao3 "SPEED CONTROL OF BRUSHLESS DC MOTOR BY USING FUZZY LOGIC PI CONTROLLER", VOL. 6, NO. 9, SEPTEMBER 2011