

## Guest Editorial

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# Digital transformation through advances in artificial intelligence and machine learning

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**Abstract.** The digital transformation (DT) is the acquiring the digital tool, techniques, approaches, mechanism etc. for the transformation of the business, applications, services and upgrading the manual process into the automation. The DT enable the efficacy of the system via automation, innovation, creativities. The another concept of DT in the engineering domain is to replace the manual and/or conventional process by means of automation to handle the big-data problems in an efficient way and harness the static/dynamic system information without knowing the system parameters. The DT represents the both opportunities and challenges to the developer and/or user in an organization, such as development and adaptation of new tool and technique in the system and society with respect to the various applications (i.e., digital twin, cybersecurity, condition monitoring and fault detection & diagnosis (FDD), forecasting and prediction, intelligent data analytics, healthcare monitoring, feature extraction and selection, intelligent manufacturing and production, future city, advanced construction, resilient infrastructure, greater sustainability etc.). Additionally, due to high impact of advanced artificial intelligent, machine learning and data analytics techniques, the harness of the profit of the DT is increased globally. Therefore, the integration of DT into all areas deliver a value to the both users as well as developer. In this editorial fifty-two different applications of DT of distinct engineering domains are presented, which includes its detailed information, state-of-the-art, methodology, proposed approach development, experimental and/or emulation-based performance demonstration and finally conclusive summary of the developed tool/technique along with the future scope.

**Keywords:** Digital transformation, advancement, artificial intelligence, machine learning, application, data analytics, cybersecurity, condition monitoring, fault detection and diagnosis, prediction, forecasting, renewable energy, feature extraction, feature selection, healthcare, greater sustainability, resilient infrastructure, automation

## 1. Introduction

This special issue focuses on digital transformation through advances in artificial intelligence and machine learning (AIaML) and is a collection of fifty two articles, which reflecting some of the current technological enhancement, development, demonstration in the real world applications such as: 1)

forecasting, 2) prediction, 3) classification, 4) condition monitoring, fault detection and diagnosis (FDD), 5) estimation, 6) traffic and transportation, 7) project planning, 8) solar energy prediction, 9) wind energy prediction, 10) electrical load forecast, 11) smart-grid CM-FDD, 12) microprocessor chip design, 13) feature extraction, 14) feature selection, 15) power system power quality analysis, 16) linear and non-linear control system analysis, 17) transformer health monitoring, 18) customer loyalty identification, 19) data pre-processing, 20) digital substation automation, 21) islanding detection in distributed generation,

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22) power extraction and monitoring, 23) occupancy detection, 24) power compensation, 25) MPPT with fluctuation conditions analysis, 26) hybrid energy sources, 27) wide area monitoring (WAM), 28) biometric system's applications, 29) fan monitoring, 30) Industrial Wireless Sensor Network (IWSN) design and monitoring, 31) data security, 31) health prognosis of energy storage system, 32) optimal power flow(OPF), 33) cybersecurity and attacks, 34) electric vehicles, 35) energy management, 36) electrical motor diagnosis, 37) power system FDD, 38) emission control, 39) clustering, 40) sensor-less monitoring, 41) electric braking system, 42) image processing, 43) health care industry, 44) power system automation, 45) market analysis and forecasting, 46) internet of things (IoT), 47) pattern reorganization, 48) optimization etc.

Nuzhat Fatema et al. [1] proposed a hybrid intelligent approach based on empirical mode decomposition (EMD), autoregressive integrated moving average (ARIMA) and Monte Carlo simulation (MCS) methods for multi-step ahead medical tourism (MT) forecasting using explanatory input variables based on two decade real-time recorded database. In the proposed hybrid model, these variables are 1st extracted then medical tourism is forecasted to perform the long term as well as the short term goal and planning in the nation.

Jafar A. Alzubi et al. [2] proposed a convolutional neural network based novel approach for driver distraction detection when a driver is distracted due to in hand electronic devices which is not only able to detect the distraction with high accuracy but also is energy and memory efficient.

Caichuan Wang and Jiajun Li [3] developed a scheme for decision making on the investment project is to analyze the feasibility and rationality of the project plan from multiple angles. This article a group decision making method based multifunctional intuitively fuzzy VIKOR interval sets.

Malik et al. [4] proposed an intelligent approach for multi-step ahead short-term wind speed forecasting (STWSF) for smart-grid application. The STWSF models are developed to forecast the wind speed into a multi-step ahead, which is used to demonstrate the daily forecast results in One-Step-Ahead (OSA), Two-Step-Ahead (TSA), and Three-Step-Ahead (ThSA) based forecasting manner.

Arun Prasath Raveendran et al. [5] proposed a fuzzy-based MIP and Graph theory-based Traffic Estimator (GTE) system, which is utilized to define a new asymmetric multiprocessor heterogene

framework on microprocessor (AHt-MPSoC) architecture. The bandwidths, energy consumption, wait and transmission range is better accomplished in this suggested technique than the standard technique and it is also implemented with a multi-task framework.

Achin Jain and Vanita Jain [6] presented a hybrid feature selection technique for sentiment classification. The authors have utilized a GA (Genetic Algorithm) and a combination of existing feature selection methods such as Information Gain (IG), CHI Square (CHI), and GINI Index (GINI). The performance of the proposed approach is demonstrated by using three databases, named IMDB Movie Review, Amazon Product Review and Yelp Restaurant Reviews. The experimental results show that proposed approach performed best in all three domain datasets.

Malik, H et al. [7] represented a novel approach for power quality disturbances (PQDs) diagnosis (PQDD), which includes real-time data generation, data pre-processing, feature extraction, feature selection, intelligent model development for PQDD. Data decomposition approach of EMD is utilized to generate the feature vector of IMFs. These features are utilized as an input variable to the intelligent classifiers. In this article PQDD is analyzed based on SVM method and obtained results are compared with conventional AI method of LVQ-NN.

A. K. Sharma and B. Bhushan [8] represents the implementation of the various fuzzy controller with robust sliding mode control (SMC) technique on a nonlinear system considering various external disturbances and model uncertainties. The nonlinear system considered here is a single link inverted pendulum. The proposed work combines the advantages of sliding mode controlling technique and fuzzy logic controller.

Md Tabrez et al. [9] proposed an equivalent circuit modelling of a three-phase to seven-phase transformer using particle swarm optimization (PSO) and Genetic Algorithm (GA). The proposed model is optimized through PSO and GA algorithms and tested for minimum voltage error in each phase.

Asif Sanaullah et al. [10] developed an intelligent model to analyzing impact of relationship benefit and commitment on developing the customer loyalty using a hybrid machine intelligence approach. Survey methodology was used to gather data from three different service sectors based on the classification by Bowen. A sample of 600 customers and responses were collected randomly from the front desk of services. The presented approach is very

useful for service industry for short-term as well long-term future planning.

B. K. Mohanta et al. [11] developed a machine learning based accident prediction in a secure IoT enables transportation system. The main motive behind this study is to predict the specific features which could affect vehicle accident severity. In this article, several classification models such as Logistic Regression, Artificial Neural network, Decision Tree, K-Nearest Neighbors, and Random Forest have been implemented for predicting the accident severity.

S. Goel, and M. Tushir [12] proposed a new semi-supervised clustering approach for incomplete data, which is unlabeled in nature. The novelty of the proposed approach is that it considers the missing features along with available knowledge (labels) of the data set.

A. Azeem et al. [13] developed a hybrid intelligent approach for real-time harmonics analysis of digital substation equipment based on IEC-61850. In this article, firstly, experimental analysis is performed to validate the laboratory prototype setup using FFT (fast Fourier transform), STFT (short-time Fourier transform) and CWT (continuous wavelet transform). Then, features are extracted from experimental dataset using EMD (empirical mode decomposition) method. The IMFs (intrinsic mode functions) have been generated from EMD, which are used as an input variable to the two different diagnostic models, i.e., ANN and J48 algorithm.

P. Ray et al. [14] developed two accurate hybrid islanding detection schemes for distribution network based on Wavelet Transform and Stockwell transform (S-transform). The proposed methods use the potential of sequence voltage (negative) retrieved at the target Distributed Generation (DG) location of the distribution network under study. The proposed schemes are tested in a distribution network consisting of two 9 MW wind farm driven by six 1.5 MW wind turbine connected to 120 kV main grid through a 25 kV, 30 km feeder.

Abhinav K. Gautam et al. [15] proposed an intelligent BWO algorithm-based maximum power extraction from solar-PV-powered BLDC motor-driven light electric vehicles. The proposed system also addresses the problems of conventional MPPT methods via a black widow spider-inspired optimization approach. The simulink results run in parallel with the Typhoon HIL 402 setup to demonstrate the experimental setup.

N. Fatema et al. [16] developed a deterministic and probabilistic occupancy detection scheme with

a novel heuristic optimization and Back-Propagation (BP) based algorithm. In this article, the GSA (Gravitational Search Algorithm) is used as a new training technique for BPNN in order to enhance the performance of the BPNN algorithm by decreasing the problem of trapping in local minima, enhance the convergence rate and optimize the weight and bias value to reduce the overall error. The proposed approach is validated with different hidden-layer neurons for both experimental studies based on BPNN and BPNNGSA.

Mohd. A. Anees et al. [17] proposed a scheme for reactive power compensation for grid by Packed-U-Cell inverter using model predictive control strategy with intelligent Multi-objective approaches. The developed prototype performs well under dynamic conditions and can successfully track the current command during step changes in the power demand.

I. Pervez et al. [18] developed an MPPT method using hybrid radial movement optimization with teaching-learning based optimization under fluctuating atmospheric conditions. The proposed algorithms have been discussed in detail and applied to multiple shading patterns in a solar PV generation system under perturb condition.

A. Riyaz et al. [19] developed an Intelligent Optimization Technique for Power Quality Enhancement of a Hybrid Energy Source Powered Packed E-Cell Inverter for micro-grid applications. Here in this study, Genetic Algorithm (GA) optimization technique is used to eliminate the harmonics. The experimental demonstration for the validation of the proposed scheme is performed by using Typhoon HIL (hardware in loop).

W. Ahmad et al. [20] represented the Development methodology and approach of the wide area monitoring system for smart grid application. In this article, the design and implementation for optimum placement of PMU in power system network (PSN) have been performed and validated by using 5 different intelligent approaches at an emulation platform. Different case studies based on IEEE 7, 14 and 30 bus system have been performed and analyzed. The obtained results for voltage estimation error and phase estimation error with and without PMU data are compared.

S. Kaur et al. [21] developed a PCANet based biometric system with fusion of palmprint and dorsal hand vein. A method using Convolution Neural Networks (CNN) to extract discriminative features from the data samples is proposed. The proposed method

gives higher accurate results in a less constrained environment.

Mohammed A. et al. [22] proposed an MPPT based on bat algorithm for photovoltaic systems working under partial shading conditions. The proposed model has been verified in both Simulink and experimental environment using Hardwar in loop (HIL) with a Typhoon HIL 402 setup. The proposed algorithm is simple and efficient, and having a low-cost microcontroller.

K. Sarita et al. [23] proposed a Principal component analysis technique for early fault detection of industrial induced draft (ID) fan, which reduce the predictive maintenance cost. The proposed technique predicts the fault of the ID fan-motor system, being applicable for other rotating industrial equipment, and also for which the failure data, or historical data, is not available.

Omar A. Alzubi [24] developed A Deep Learning-based Frechet and Dirichlet Model for Intrusion Detection in IWSN (Industrial Wireless Sensor Network). In order to improve intrusion detection rate (IDR) with minimum time, generalized Frechet Hyperbolic Deep and Dirichlet Secured (FHD-DS) data communication model is developed. The observed results show that the generalized FHD-DS data communication method achieves higher IDR with minimum time.

Ibrahim Alsaidan et al. [25] proposed an intelligent model using different AI methods for solar energy forecasting, which is a step towards sustainable power generating system. The forecasting accuracy of the developed models is evaluated based on statistical indices such as absolute relative error and mean absolute percentage error.

V. S. Bisht et al. [26] proposed a data-driven intelligent hybrid method for health prognosis of lithium-ion batteries. For this a new health indicator is proposed and used for the RUL estimation in place of actual capacity or internal resistance value.

S. Malik and P. Bansal [27] developed a multi-modal semantic analysis with regularized semantic autoencoder for real world data by using Conditional Principal label space transformation (CPLST).

V. Srivastava and S. Srivastava [28] proposed a hybrid optimization based PID control of ball and beam system to control ball position and beam angle. In this article, two hybrid algorithms namely PSO-GSA and PSO-GWO are utilized to tune controller parameters which in turn improve the system performance.

S. Gupta et al. [29] illustrated a whale optimization based synchronization and control of two identical fractional order financial chaotic systems. To show the efficacy of the proposed method, analysis is performed for orders between [0 to 1], and also for sensitivity to initial conditions.

S. Tyagi et al. [30] illustrated a multimodal biometric system using deep learning based on face and finger vein fusion. The experimental results over all considered public databases show a significant improvement in terms of identification and recognition accuracy as well as equal error rates.

R. Devarapalli et al. [31] developed an approach to solve optimal power flow (OPF) problems using a novel hybrid whale and sine cosine optimization algorithm. To validate the performance of proposed technique, the results are compared with other methods available in the literature.

N.S. Bhati, M. Khari [32] demonstrated a new ensemble based approach for intrusion detection system (IDS) using Voting. The experiment is performed on the KDDCup99 Dataset. The results based on performing the experiment in Python fetched an accuracy of 99.90%.

S. Sarin et al. [33] developed a CNN-based multi-modal touchless biometric recognition system using gait and speech. The paper also explores various fusion strategies for combining the two pipelines and shows how various metrics get affected with different fusion strategies.

P. Meghana et al. [34] proposed a blockchain technology based decentralized energy management/scheduling system in multi-microgrids (MGs) including electric vehicles. To enhance the security and trust, blockchain technology can be incorporated. The market is shifted to decentralized state by using blockchain. The system was simulated using IEEE 118 bus feeder which consists of 5 MGs.

M. Hasan et al. [35] developed a fuzzy rule based control algorithm for MPPT to drive the brushless DC motor based water pump. The performance of proposed fuzzy rule based control algorithm is demonstrated using simulation results on MATLAB platform.

Noor Akhmad Setiawan et al. [36] proposed a classification of arrhythmia's ECG signal using cascade transparent classifier. Feature extraction and feature classification methodology is adopted to show the performance of the proposed approach. Classification performance was evaluated with publicly available dataset, the MIT-BIH Physionet Dataset using 10-fold cross validation.

P. Srikanth and C. Koley [37] developed a fuzzified time-frequency method for identification and localization of power system faults (i.e., Asymmetrical Phase Faults, Asymmetrical Ground Faults, and Symmetrical Phase faults). In this work, IEEE-9 and IEEE-14 bus systems have been considered as the test systems for validating the proposed methodology for identification and localization of Power System Faults.

B Venkateswara Rao et al. [38] represented an application of bat algorithm for wind integrated power system to reduce emission. The proposed case study, i.e., considering wind plant and SVC with BA, is applied on the IEEE30 bus system to validate the performance of the proposed approach.

S. Singh and S. Srivastava [39] proposed a Kernel fuzzy C-means clustering with teaching learning based optimization algorithm (TLBO-KFCM). Simulation using five data sets are performed and the results are compared with two other optimization algorithms (genetic algorithm GA and particle swarm optimization PSO).

Suryakant et al. [40] developed an Improved ANFIS based MRAC observer for Sensorless Control model for permanent magnet synchronous motor (PMSM). In the proposed method adaptive model and adaptive mechanism are replaced by an improved ANFIS controller, which neutralize the effect of parametric variation and results in improved performance of the drive.

I. Kumar et al. [41] proposed an automated white corpuscles nucleus segmentation using a deep neural network from microscopic blood smear. The proposed model uses the combination of 'binary\_cross\_entropy' and 'adam' for maintaining learning rate in each network weight. To validate the potential and capability of the above proposed solution, ALL-IDB2 dataset is used.

Abhinav K. Gautam et al. [42] proposed an optimal power management strategy of regenerative braking using fuzzy logic controller for BLDC motor-driven E-Rickshaw. In Hybrid energy sources, solar power is used to charge a battery (primary source) that is effectively coupled to an ultra-capacitor (ancillary source) for peak demand supplies.

Majed A. Alotaibi et al. [43] developed a new hybrid model combining EMD and neural network for multi-step ahead load forecasting, which is most prominent for the distinct applications of MPS and VPP such as real-time analysis of energy storage system, distributed energy resources, demand side management and electric vehicles etc. The model per-

formance is demonstrated by using historical dataset collected from GEFCom2012 and GEFCom2014.

S. Dhingra and P. Bansal [44] represented the designing of a rigorous image retrieval system with amalgamation of artificial intelligent techniques and relevance feedback. In this implementation, an exclusive and competent content based image retrieval (CBIR) system is schemed by the integration of Color moment (CM) and Local binary pattern (LBP). In this article, two artificial intelligent CBIR models are proposed, first one is (Hybrid + SVM + RF) and second is (Hybrid + CFBPNN + RF) and their performance parameters are compared.

D. Prasad et al. [45] proposed a grid interfaced solar-wind hybrid power generating systems using fuzzy-based TOGI control technique for power quality improvement. The proposed system includes the solar photovoltaic, permanent magnet based synchronous generator (PMSG), DC-DC converter, MPPT based on incremental conductance, three phases IGBT based voltage source converter (VSC), with a third order generalized integrator (TOGI) control technique. Test results are performed by using within the IEEE-519 standard.

S. Sharma et al. [46] developed a control loop oscillation detection and quantification system using PRONY method of IIR filter design and deep neural network. Experimental results confirm that the presented algorithm is capable of detecting the presence of single or multiple oscillations in the control loop data and the proposed algorithm is also able to estimate the frequency and amplitude of detected oscillations with high accuracy.

N. Fatema et al. [47] proposed a data-driven intelligent model for quality management in healthcare. Quality management in healthcare incorporates with making of various quality policies, quality planning and assurance, quality control and quality improvement. Quality improvement (QI) is the scheme used for betterment of the services delivered to the patients, such as diagnosis and treatment. In this article artificial intelligence and machine learning techniques have been implemented to enhance the diagnosis accuracy of the liver fibrosis which is caused by hepatitis C virus (HCV). The proposed data-driven intelligent model for identification of liver fibrosis using hybrid approach is designed and implemented to overcome the SLBs problems with higher diagnostic accuracy.

P. Srikanth and C. Koley [48] developed a deep learning and signal processing based algorithm for autorecognition of harmonic loads in the power sys-

tem network. A convolution neural network (CNN) based deep learning method has been proposed for automatic classification and localization of nonlinear loads present in an interconnected power system. The proposed approach avoids the usage of any additional fusion layer for obtaining unique features, reduces the training time and maintains the highest accuracy of 100%.

N. Kumar and MM. Tripathi [49] represented an investigation on effect of solar energy generation on electricity price forecasting and demonstrated results are compared with LSTM method. The forecasted electricity price considering the factor of solar energy generation was lower as compared with the forecast without solar energy generation.

S. P. Ajith Kumar et al. [50] proposed a distributed probability density based multi-objective routing system for Opp-IoT networks enabled by machine learning. The proposed approach opportunistic fuzzy clustering routing (OFCR) protocol employs a three-tiered intelligent fuzzy clustering-based paradigm that allows representation of multiple properties of a single entity and the degree of association of the entity with each property group.

Abdulaziz Almutairi et al. [51] developed a cyberattacks identification model for IEC 61850 based substation using proximal support vector machine for maintaining the reliable, efficient, secure and multi-functional. In this article, few of the most serious threats (i.e., DoS (Denial of Services), MS (Message Suppression) and DM (Data Manipulation) attacks, where DoS is due to flood bogus frames) in the substation automation system (SAS) are analyzed. The obtained results of the demonstrated study shows the effectiveness and high level of acceptability for real side implementation to protect the SAS from the cyberattacks in different scenarios.

J. Singh et al. [52] proposed an intelligent framework for detecting fatigue induced by sleep-deprivation. The proposed method is non-intrusive, in which the subject is unaware of being monitored during the test, which helps to prevent biased results.

In conclusion, we express our gratitude to many people whose continuous support and co-ordination have made this special issue production successful. As guest editors, we specially thank the authors for their contributions. We are grateful to the reviewers for their valuable comments and prompt responses. We deeply thank to the JIFS Editor-in-chief and staff for their immense support and guidance during the complete process of this special issue.

Hasmat Malik, Gopal and Smriti Srivastava  
Guest editor(s)

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