RESEARCH ARTICLE OPEN ACCESS

Auto Mobile manufacturing system of HVAC by Markov modelling

Mr.J.Naren
Department Of CSE School of Computing Sastra University – Tirumalaisamudram

ABSTRACT

The present research work an attempt has been made to model the performance of a condenser manufacturing system of a HVAC plant using Markov modelling technique and also priorities the maintenance repair activities on the basis of analysis. The system comprises with six sub-systems namely Helium Leak Testing Machine(HLT), Tungsten Inert Gas (TIG) welding, Fins Assembly machine, Inner Leak Testing(ILT), Air Leak Testing Machine(ALT), core building, fluxing and brazing machines. The various Chapman-Kolmogorov differential equations have been derived on the basis of state transition diagram. A different combination of repair and failure rates of all subsystems represents the availability matrices. The plot of repair and failure rates of various subsystems with the availability stage accomplished in availability matrices evaluates the performance of all subsystems. The repair rate decides the maintenance main concern of different subsystems of condenser manufacturing systems.

I. INTRODUCTION

The organizations are changed consistently by means of the progression in today's spirited world. For production units, the vulnerable opportunities and different issues, political, financial and innovative influences dynamic conditions with various changes [11]. With higher coefficients in their procedures between the productions industries present lot of manufacturing threats. The work creation and the coordinate relationship with human life from one viewpoint salary of moving, further, have ambitious the industry to storm up one of the key industries in every locale [1]. Based on time span of usability, the novel trending innovations for additional procedures and traceability of materials are important one. This is current endeavors instances by the intention to develop the production system manageability [3]. The material production has ascended as of not on time remarkably. Especially, the manufacturing process, augmentation of agricultural production regions and utilization of fertilizers are increasing rapidly. The vital job in the achievement of any business are nature of goods assume, HR, cost and time parameters. The business failures are prompted with inefficient or failures in every one of these fields [12].

The substanceas of altering in excess of raw materials awaiting the point in the manufacturing industry that are caused with various hazard factors those punctual accomplishing critical items, which have unsalvageable monetary ramifications and power customers' health for the material production industry [5]. The management in the direction of comprehends the crashes of changes in the repair or failure charges of the components in a structure are caused by reliability of the framework and long-run accessibility model. By expanding the capacity of the system or giving adequate excess parts acquires with high reliability and the expansion in the unpredictability of the scheme [2]. In the past decades, The Flow Network, Fault Tree Analysis (FTA), Reliability Block Diagrams (RBD), Markov based chain models with cluster technique are used to analyze the availability. In this work, the similar or a combination of both the setups with huge multifaceted structure units arranged in arrangement involved in embrace developed of manifold congregation for condenser. The x-ray machine, infeed transport, heat exchanger, seasoning machine and fryer are the important portion of these units, which is arranged in sequential and the blend or parallel of both. The contribution of this employment is to generate availability representation dependent on failure and repair rate via employing arithmetical method [16,17]. The availability of automobile HVAC manufacturing system with its availability is analyzed and evaluated in this present study using Markov Process in which the HVAC manufacturing system of plant placed in Bhiwari, Haryana, India. Further, the Cooling Fan, Condenser and Radiator are the three important parameters in the cooling module. Particularly, the condenser part is used in this study.

II. RELATED WORKS

Digital Feed Water Control System (DFWCS) was proposed by Pramod Kumar et al. 2020 [4] based on the nuclear power plant that considered the main-steam safety valves with repair and maintenance. On account of classical models fail as of multiple failure modes for

components, functional dependencies among components, uncertainty in system behavior and failure data with temporal system behavior. The Stochastic Petri Net capturing models the system. The comprehensive study demonstrates better state-transition probabilities. The data center cooling system under waterside economization performance was analyzed by Andres et al. (2019) [7]. The Engineering Equation Solver (EES) solves the set of thermodynamic equations continuously via a modeled in steady state. Further, the Water to Energy Ratio (WER) with Coefficient of Performance (COP) evaluates the system performance. The system to store the cooling energy as 1MWh. The favorable climates includes tundra (ET), temperate rainy (Cfb) and winter rain (Csc) climates implements the water-side economizers.

The evacuated tube solar collector's integration into a novel solar polygeneration plant was presented by Francesco Calise et al. (2019) [9]. The economic and energy power plant performance evaluates the system performance. The biomass auxiliary heaters are produced by combining solar heat. The zero-dimensional dynamic representation simulates the plant. The feed-in tariffs is improved by economic profitability. The gas turbine in an offshore oil with organic Rankine cycle coupled platform was proposed by Max Mauro et al. (2019) [10] to optimize the power production and analyze the off-design performance. The dynamic operating conditions with organic Rankine cycle availability develop the off-design system model. The performance characteristics of the system and main irreversibilities are determined by energy analysis.

A few specialists referenced restraints of FMEA in the history section in any cases. Yang, J., et al. 2011 [11] griped the distorted Dempster– Shafer process in the direction of entirety the varied appraisal information through bearing in mind dissimilar specialists' appraisal conclusions, failure modes and three hazard issues independently. The handy application proposes an improved insight outline. Under various sources of unverifiable assessment data, this method is operated to control the threat main concern evaluation of the failed techniques of rotor cutting edges of an aircraft turbine at long last. This technique yielded better results. Enitan, A.M. and, Adeyemo, J., 2011 [6] and Wari, E., and Zhu, [13] contrasted the various sort exhibitions with evolutionary methods.

III. METHODOLOGY

In manufacturing condenser system, the performance modeling and availability analysis are the major intention of this work. This system has six sub-systems namely core building, fluxing and brazing machine, air leak testing machine, inner leak testing, and assembly machine, TIG welding, and helium leak testing machine. These subsystems are associated in series or parallel with one another. For these six sub-frameworks, the utilization of mnemonicrule with the mathematical formulation of the model is produced thereby assuming the exponential dissemination of FR and RR of sub-frameworks. Chapman-Kolmogorov differential conditions are obtained from the progress summarizes. According to the probabilistic methodology utilizing Markov process that produces the scientific model of assembly area. By utilizing simulation modeling to select the most optimal subsystems in the plant and the execution of each sub-system of the framework is improved. The production model is made with the help of an efficient production system in which it change a huge contributions to few ideal outcomes. The novel approch of Markov modelling with its simulations are used in this work to analyze the production system availability with its improtance.

3.1System structure:

The condenser section assembles with six subsystems. The entire subsystem completely failed due to both machines failed and the failure of anyone does not affect the system in subsystem 1. For fluxing and bracing, the the furnace divided into 3 zones in subsystem 2. The complete failure of the system is caused by failures of this processing in machine in subsystem 2 and 3. After Air Leak Testing (ALT) happens in TIG Welding (TW) based on subsystem 4. The capacity state reduces the complete failure of this failure of any one in subsystem 5. Both of machines are failed then the failure of the system happens. The complete system failure is caused due to the failure of the Processing in subsystem 6. The production model makes the production system in which it changes many of contributions to stable outputs. In this work, the Markov model is used to determine the production framework availability.

3.1Markov Process

The Markov process based on the method is to decide the availability of the framework. While their fix times are self-assertively disseminated then the distinctive subcomponents system with FR is considered as consistent. From the Transition Diagram (TD), differential conditions are effectively obtained and to determine the Markov process that are most extreme execution. Figure 1 explains the relating TD of included states appears.

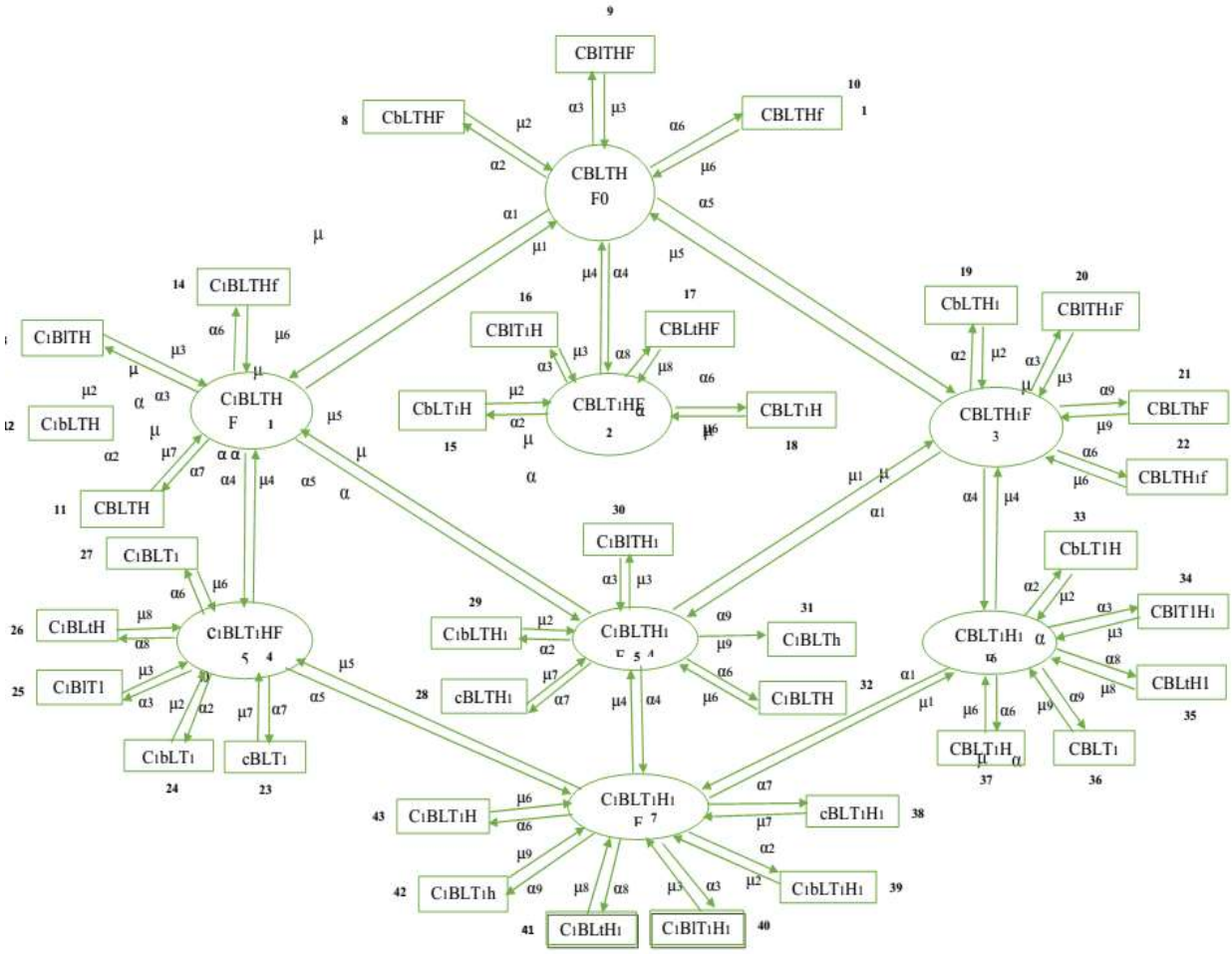

Figure 1: Flow diagram of an assembly of condenser manufacturing process

Notations and Declaration of variables used in Flow Diagram

Figure 1 represents the notions associated with the TD are as follows:

Prescribes the full, reduced and failed state capacity of the system

Declaration of variables

C, B, L, T, H Subsystem in the operating state

c, b, l, t, h Failed state of C, B, L, T, H

α_i, μ_i Mean FR & RR of $C, B_i, L, T and H_j$

C_0 The probability of the system in working with full capacity at time z

$(')$ Derivatives with respect to *z*

The Markov process denotes the transitions and its states. Here, the failed or good by the disappointment of every segment depicts the conceivable states of the system [14]. According to Markov birth-death process, the differential conditions associated to the TD are inferred. The differential conditions accompanying arrangements are created with various probability contemplations. The following differential equation explains the markov processing.

IV. RESULT DISCUSSION

The i5 processors and 4GB RAM with MATLAB 2016a platform handles the implementation process of numerical modeling. While related to transition diagram, the differential equations and probabilistic approach with Markov process prepares the modeling for the condenser manufacturing process. Each sub-system, both FR and RR influence the proposed system and its validating results are discussed as follows.

1) *Effect of FR and RR in subsystem 1 (CB m/c):*

Table 1 explains the system availability of subsystem based on CBM. Here, the repair and failures rates are with different system availability such as 0.14, 0.24, 0.34, 0.44, 0.54, 0.64 and 0.74 are considered thereby the constant parameters are listed in the tabulation. The subsystem 1 delivers better availability outputs.

Table 1: System availability of Subsystem 1-CBM (i)

RR / FR	*System availability*							*Constant parameters*	
	0.14	**0.24**	**0.34**	**0.44**	**0.54**	**0.64**	**0.74**	**FR**	**RR**
0.038	0.8654	0.8824	0.8906	0.8955	0.8988	0.9011	0.9029	$\alpha_2 = 0.008$ $\alpha_3 = 0.017$ $\alpha_4 = 0.021$ $\alpha_5, \alpha_8 = 0.20$ $\alpha_6, \alpha_9 = 0.0038$ $\alpha_7 = 0.118$	$\mu_2 = 0.65$ $\mu_3 = 0.61$ $\mu_4 = 0.20$ $\mu_5, \mu_8 = 0.16$ $\mu_6, \mu_9 = 0.02$ $\mu_7 = 0.42$
0.068	0.8418	0.8661	0.8781	0.8854	0.8902	0.8937	0.8963		
0.098	0.8223	0.8519	0.8669	0.8761	0.8823	0.8868	0.8902		
0.128	0.806	0.8394	0.8568	0.8676	0.875	0.8803	0.8844		
0.158	0.792	0.8284	0.8477	0.8598	0.8682	0.8743	0.8789		
0.188	0.78	0.8185	0.8394	0.8527	0.8618	0.8686	0.8738		
0.218	0.7695	0.8096	0.8319	0.846	0.8559	0.8633	0.8689		

2) Effect of FR and RR in subsystem 2 (FB m/c):

Table 2 depicts the system availability of subsystem based on FB. Here, the repair and failures rates are with different system availability such as 0.35, 0.4, 0.55, 0.65, 0.75, 0.85 and 0.95 are taken thereby the constant parameters od both FR and RR are listed in the tabulation. The subsystem 2 provides excellent availability outputs.

Table 2: System availability of Subsystem 2-FB m/c

RR / FR	*System availability*							*Constant parameters*	
	0.35	**0.45**	**0.55**	**0.65**	**0.75**	**0.85**	**0.95**	**FR**	**RR**
0.002	0.8726	0.8736	0.8742	0.8746	0.8749	0.8752	0.8754	$\alpha_1 = 0.128$ $\alpha_3 = 0.017$ $\alpha_4 = 0.021$ $\alpha_5, \alpha_8 = 0.20$ $\alpha_6, \alpha_9 = 0.0038$ $\alpha_7 = 0.118$	$\mu_1 = 0.44$ $\mu_3 = 0.61$ $\mu_4 = 0.20$ $\mu_5, \mu_8 = 0.16$ $\mu_6, \mu_9 = 0.02$ $\mu_7 = 0.42$
0.004	0.8683	0.8702	0.8714	0.8723	0.8729	0.8734	0.8738		
0.006	0.864	0.8668	0.8687	0.8699	0.8709	0.8716	0.8721		
0.008	0.8597	0.8635	0.8659	0.8676	0.8689	0.8698	0.8705		
0.01	0.8555	0.8602	0.8632	0.8653	0.8668	0.868	0.869		
0.012	0.8514	0.8569	0.8605	0.863	0.8648	0.8663	0.8674		
0.014	0.8473	0.8537	0.8578	0.8607	0.8629	0.8645	0.8658		

V. CONCLUSION

This article proposed Markov model to analyze the condenser manufacture system in a HVAC plant and its availability of manifold assembly, which was executed on MATLAB software. The Markov model executes the probability distribution and thereby considering both exponential distribution of subsystems such as FR and RR. In the manufacturing system, the FR and RR of MAC subsystems contain huge system availability effect. The subsystem 7 that maximum availability of 0.9923 by minimizing FR. The FR contains constant parameters such as are 0.128, 0.008, 0.017, 0.021, 0.20, 0.0038, and 0.118, and the RR as 0.44, 0.65, 0.61, 0.16, 0.02, and 0.42 in condenser manufacturing. While compared to existing methods, the markov process demonstrates extreme availability. The results of the paper are very beneficial to the plant administration for overall performability enhancement by deciding the appropriate maintenance priorities for condenser manufacturing System. Furthermore, availability of concerned system will optimize in future with the help of different optimization techniques.

REFERENCES

[1] Vaiyapuri, T., Parvathy, V. S., Manikandan, V., Krishnaraj, N., Gupta, D., & Shankar, K. (2021). A Novel Hybrid Optimization for Cluster-Based Routing Protocol in Information-Centric Wireless Sensor Networks for IoT Based Mobile Edge Computing. Wireless Personal Communications, 1-24.

[2] Raveendran, A. P., Alzubi, J. A., Sekaran, R., & Ramachandran, M. A high performance scalable fuzzy based modified Asymmetric Heterogene Multiprocessor System on Chip (AHt-MPSOC) reconfigurable architecture. Journal of Intelligent & Fuzzy Systems, (Preprint), 1-12.

[3] Mansour, Romany F., and A. A. Marghilani. "A new technique to fingerprint recognition based on partial window." Computer Engineering and Intelligent Systems 3.10 (2012): 63-76.

[4] Namasudra, S. (2020). Fast and Secure Data Accessing by using DNA Computing for the Cloud Environment. IEEE Transactions on Services Computing.

[5] Goli, A., Zare, H. K., Moghaddam, R. T., & Sadeghieh, A. (2019). An improved artificial intelligence based on gray wolf optimization and cultural algorithm to predict demand for dairy products: a case study. IJIMAI, 5(6), 15-22.

[6] Elhoseny, M., Shankar, K., & Uthayakumar, J. (2019). Intelligent diagnostic prediction and classification system for chronic kidney disease. Scientific reports, 9(1), 1-14.

[7] Alzubi, J. A. (2020). Bipolar fully recurrent deep structured neural learning based attack detection for securing industrial sensor networks. Transactions on Emerging Telecommunications Technologies, e4069.

[8] Mansour, R. F. (2015). Using adaptive mutation to accelerate the convergence of immune algorithms for prediction of 3D molecular structure. International Journal of Computers and Applications, 37(3-4), 127-133.

[9] Namasudra, S., Sharma, S., Deka, G. C., & Lorenz, P. (2020). DNA computing and table based data accessing in the cloud environment. Journal of Network and Computer Applications, 172, 102835.

[10] Namasudra, S., & Deka, G. C. (2020). Applications of Blockchain in Healthcare. Springer Singapore Pte. Limited.

[11] Joshi, R. C., Singh, A. G., Joshi, M., & Mathur, S. (2019). A Low Cost and Computationally Efficient Approach for Occlusion Handling in Video Surveillance Systems. International Journal of Interactive Multimedia & Artificial Intelligence, 5(7).

[12] Le, D. N., Parvathy, V. S., Gupta, D., Khanna, A., Rodrigues, J. J., & Shankar, K. (2021). IoT enabled depthwise separable convolution neural network with deep support vector machine for COVID-19 diagnosis and classification. International Journal of Machine Learning and Cybernetics, 1-14.

[13] Babu, M. V., Alzubi, J. A., Sekaran, R., Patan, R., Ramachandran, M., & Gupta, D. (2020). An Improved IDAF-FIT Clustering Based ASLPP-RR Routing with Secure Data Aggregation in Wireless Sensor Network. Mobile Networks and Applications, 1-9.

[14] Mansour, R. F. (2017). Evolutionary computing enriched ridge regression model for craniofacial reconstruction. Multimedia Tools and Applications, 1-18.

[15] Namasudra, S., Chakraborty, R., Majumder, A., & Moparthi, N. R. (2020). Securing Multimedia by Using DNA-Based Encryption in the Cloud Computing Environment. ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM), 16(3s), 1-19.

[16] Rodríguez, J., Corredor, B., & Suárez, C. (2019). Genetic Operators Applied to Symmetric Cryptography. International Journal of

Interactive Multimedia & Artificial Intelligence, 5(7).

[17] Raj, R. J. S., Prakash, M. V., Prince, T., Shankar, K., Varadarajan, V., & Nonyelu, F. (2020). WEB BASED DATABASE SECURITY IN INTERNET OF THINGS USING FULLY HOMOMORPHIC ENCRYPTION AND DISCRETE BEE COLONY OPTIMIZATION. Malaysian Journal of Computer Science, 1-14.

[18] Hamdoun, H., Nazir, S., Alzubi, J. A., Laskot, P., & Alzubi, O. A. (2021). Performance benefits of network coding for HEVC video communications in satellite networks. Iranian Journal of Electrical and Electronic Engineering, 1956-1956.

[19] Marghilnai, A. L. (2017). Abdulsamad, and RF Mansour," Wavelet filter techniques for segmenting retinal blood vessels,". International Journal of Advanced and Applied Sciences, 4(9), 156-160.

[20] Namasudra, S., Chakraborty, R., Kadry, S., Manogaran, G., & Rawal, B. S. (2020). FAST: Fast accessing scheme for data transmission in cloud computing. Peer-to-Peer Networking and Applications, 1-13.

[21] Arora, S., & Singh, S. (2017). An Effective Hybrid Butterfly Optimization Algorithm with Artificial Bee Colony for Numerical Optimization. International Journal of Interactive Multimedia & Artificial Intelligence, 4(4).

[22] Shankar, K., Perumal, E., Elhoseny, M., & Nguyen, P. T. (2021). An IoT-Cloud Based Intelligent Computer-Aided Diagnosis of Diabetic Retinopathy Stage Classification Using Deep Learning Approach. CMC-COMPUTERS MATERIALS & CONTINUA, 66(2), 1665-1680.

[23] Amiri, I. S., Palai, G., Alzubi, J. A., & Nayak, S. R. (2020). Chip to chip communication through the photonic integrated circuit: A new paradigm to optical VLSI. Optik, 202, 163588.

[24] Mansour, R. F. (2011). Applying an evolutionary algorithm for protein structure prediction. American Journal of Bioinformatics Research, 1(1), 18-23.

[25] Namasudra, S., & Roy, P. (2017). Time saving protocol for data accessing in cloud computing. IET Communications, 11(10), 1558-1565.

[26] Dur-e-Ahmad, M., & Imran, M. (2020). Transmission Dynamics Model of Coronavirus COVID-19 for the Outbreak in Most Affected Countries of the World. International Journal of Interactive Multimedia & Artificial Intelligence, 6(2).

[27] Pustokhin, D. A., Pustokhina, I. V., Dinh, P. N., Phan, S. V., Nguyen, G. N., & Joshi, G. P. (2020). An effective deep residual network based class attention layer with bidirectional LSTM for diagnosis and classification of COVID-19. Journal of Applied Statistics, 1-18.

[28] Alrabea, A., Alzubi, O. A., & Alzubi, J. A. (2019). A task-based model for minimizing energy consumption in WSNs. Energy Systems, 1-18.

[29] Mansour, R. F. (2020). A robust deep neural network based breast cancer detection and classification. International Journal of Computational Intelligence and Applications, 19(01), 2050007.

[30] Namasudra, S., Roy, P., Vijayakumar, P., Audithan, S., & Balusamy, B. (2017). Time efficient secure DNA based access control model for cloud computing environment. Future Generation Computer Systems, 73, 90-105.

[31] García, C. G., Zhao, L., & García-Díaz, V. (2019). A User-Oriented Language for Specifying Interconnections between Heterogeneous Objects in the Internet of Things. IEEE Internet of Things Journal, 6(2), 3806-3819.

[32] Anupama, C. S. S., Sivaram, M., Lydia, E. L., Gupta, D., & Shankar, K. (2020). Synergic deep learning model–based automated detection and classification of brain intracranial hemorrhage images in wearable networks. Personal and Ubiquitous Computing, 1-10.

[33] Alzubi, O. A., Alzubi, J. A., Dorgham, O., & Alsayyed, M. (2020). Cryptosystem design based on Hermitian curves for IoT security. The Journal of Supercomputing, 76(11), 8566-8589.

[34] Mansour, R. F. (2012). A robust method for arabic car plates recognition and matching using chain code. American Journal of Computational and Applied Mathematics, 2(3), 105-111.

[35] Namasudra, S. (2021). Data access control in the cloud computing environment for bioinformatics. International Journal of Applied Research in Bioinformatics (IJARB), 11(1), 40-50.

[36] Cueva-Fernandez, G., Espada, J. P., García-Díaz, V., & Gonzalez-Crespo, R. (2015). Fuzzy decision method to improve the information exchange in a vehicle sensor tracking system. Applied Soft Computing, 35, 708-716.

[37] Alqaralleh, B. A., Mohanty, S. N., Gupta, D., Khanna, A., Shankar, K., & Vaiyapuri, T. (2020). Reliable Multi-Object Tracking Model Using Deep Learning and Energy Efficient

Wireless Multimedia Sensor Networks. IEEE Access, 8, 213426-213436.

[38] Alzubi, J. A., Manikandan, R., Alzubi, O. A., Qiqieh, I., Rahim, R., Gupta, D., & Khanna, A. (2020). Hashed Needham Schroeder industrial IoT based cost optimized deep secured data transmission in cloud. Measurement, 150, 107077.

[39] Mansour, R. F., & Abdelrahim, E. M. (2019). An evolutionary computing enriched RS attack resilient medical image steganography model for telemedicine applications. Multidimensional Systems and Signal Processing, 30(2), 791-814.

[40] Chakraborty, R., Verma, G., & Namasudra, S. (2020). IFODPSO-based multi-level image segmentation scheme aided with Masi entropy. Journal of Ambient Intelligence and Humanized Computing, 1-19.

[41] García-Díaz, V., Fernández-Fernández, H., Palacios-González, E., G-Bustelo, B. C. P., Sanjuán-Martínez, O., & Lovelle, J. M. C. (2010). Talisman mde: Mixing MDE principles. Journal of Systems and Software, 83(7), 1179-1191.

[42] Shankar, K., & Perumal, E. (2020). A novel hand-crafted with deep learning features based fusion model for COVID-19 diagnosis and classification using chest X-ray images. Complex & Intelligent Systems, 1-17.

[43] Alzubi, O. A., Alzubi, J. A., Alweshah, M., Qiqieh, I., Al-Shami, S., & Ramachandran, M. (2020). An optimal pruning algorithm of classifier ensembles: dynamic programming approach. Neural Computing and Applications, 32(20), 16091-16107.

[44] Cueva-Fernandez, G., Espada, J. P., García-Díaz, V., Crespo, R. G., & Garcia-Fernandez, N. (2016). Fuzzy system to adapt web voice interfaces dynamically in a vehicle sensor tracking application definition. Soft Computing, 20(8), 3321-3334.

[45] Mansour, R. F. (2012). Multiple Views Effective for Gait Recognition Based on Contours. Computer Engineering and Intelligent Systems, 3(10), 50-62.

[46] Alzubi, J. A., Jain, R., Kathuria, A., Khandelwal, A., Saxena, A., & Singh, A. (2020). Paraphrase identification using collaborative adversarial networks. Journal of Intelligent & Fuzzy Systems, (Preprint), 1-12.

[47] Pavithran, P., Mathew, S., Namasudra, S., & Lorenz, P. (2020). A Novel Cryptosystem based on DNA Cryptography and Randomly Generated Mealy Machine. Computers & Security, 102160.

[48] Elhoseny, M., & Shankar, K. (2019). Reliable data transmission model for mobile ad hoc network using signcryption technique. IEEE Transactions on Reliability, 69(3), 1077-1086.

[49] Nieto, Y., García-Díaz, V., Montenegro, C., & Crespo, R. G. (2019). Supporting academic decision making at higher educational institutions using machine learning-based algorithms. Soft Computing, 23(12), 4145-4153.

[50] Miled, A. B., Dhaouadi, R., & Mansour, R. F. (2020). Knowledge Deduction and Reuse Application to the Products' Design Process. International Journal of Software Engineering and Knowledge Engineering, 30(02), 217-237.