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Comparative Analysis of Recent Plant Leaves Disease Detection and Classification Models

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ABSTRACT

Currently, automated recognition of disease by plant images is a highly crucial and main issue for farming and acquired the attention of investigators. Till now, this methodology is overlooked in their chance and entirely depends on DL systems. The efficacy of CNN was enhanced as a potential gadget for prognosing and estimating the infection from crop images. This research has studied numerous NN methodologies which were used for image processing data with importance on recognizing crop ailments. At first, an examination of data acquisition resources, DL frameworks or techniques, and different image processing methodologies were used for processing the provided imaging data. Subsequently, the research highlighted the results reached from the valuation of numerous current DL systems and finally specified the futuristic feasibility of data analyses. The training of this study is permitting upcoming examinations for learning huge capabilities of DL whenever identifying plant diseases through advancing accuracy and performance of the system.

Keywords: Deep learning, Single Shot MultiBox Detector, Inception-v3, Artificial intelligence, NASNet system.

I. INTRODUCTION

In agribusiness things, diseases are the essential driver for the diminishing in both quality and formation of the agriculture things [1]. Thusly, plant ailment finding in starting stage is incredibly basic for fixing and controlling them. Farmers invest their fantastic energy in picking best seeds of plants and give genuine environment to the development of the plant, regardless of the way that there is bundle of afflictions that impact plants achieve plant sickness [2-4]. In cultivation, it is basic to observe the plant disease bunches initially stage which helps us with restricting the damage, diminish creation costs, and rise the compensation [5]. The normal eye alone isn't that much convincing various on numerous occasions to perceive the right affliction [6]. In past farmers used to follow unaided eye impression of experts with trials of affected plants or experts used to visit the residents and considering their thoughts farmers were taking the healing action to fix the plant infections [7]. In this procedure, it is incredibly difficult to find trust admirable experts and the game plan doesn't turn out true to form for the huge fields, the methodology takes long time. Moreover, this method is expensive in light of the fact that it requires endless observing of subject matter experts. Agriculture is the root of the economy of any country in this way the right and advantageous distinctive verification of cultivating things sicknesses is vital [8]. In this manner, we truly need a couple of modified, fast, accurate, and more reasonable methods to perceive ailments. Current innovative progress in the field of picture handling and AI will help farmers in the piece cost lessening of pesticides [9-10]. Essentially there are two kinds of variables which cause the diseases in the agribusiness things; living and non-living trained professionals [11-13]. Bugs, minuscule creatures, parasites, and diseases go under the arrangement of living experts while temperature changes, overabundance clamminess, insufficient light, less enhancements, and tainting in air go under non-living trained professionals [14]. Cultivation related various applications are created for leaf recognizing verification, lead disease acknowledgment, normal item infections, and so on [15-17]. This huge number of usages require advanced pictures which are gotten through automated cameras. Then, at that point, picture handling and AI methods are applied to get pictures to isolate major information for the assessment [18]. In this paper, we are presenting overview of various plant disease distinguishing proof and gathering techniques using picture handling and AI which is used for speedy, unconstrained, modified, and precise discovery as well as portrayal of plant leaf afflictions [19-22]. The various periods of contamination acknowledgment and ID are picture getting, picture pre-handling, picture division, feature extraction, and gathering [23].

In this study, the research has studied numerous NN methodologies which were used for image processing data with importance on recognizing crop ailments. At first, an examination of data acquisition resources, DL frameworks or techniques, and different image processing methodologies were used for processing the provided imaging data. Subsequently, the research highlighted the results reached from the valuation of

numerous current DL systems and finally specified the futuristic feasibility of data analyses. The training of this study is permitting upcoming examinations for learning huge capabilities of DL whenever identifying plant diseases through advancing accuracy and performance of the system.

II. RELATED WORKS

The review is revolved around a unique method to improve plant disease affirmation module that is depending on leave picture portrayal, using DCNN system [24-27]. Creative readiness and the technique help a straightforward and quick execution progressively [28]. The laid out module can perceive thirteen specific kinds of plant ailment from improved leaves, with the ability to isolate plant leaves from their environmental factors [29]. Taking into account this data, an approach for recognizing plant disease was introduced. [30-32] Actually the focus on plant ailment and irritation affirmation depending DL from 3 features of division, acknowledgment, and gathering associations, and the disservices and advantages of every single procedure are outlined [33]. Notable datasets are presented, and the productivity of present assessment is associated. Considering this assessment thinks colossal issues consistently applications. Moreover, possible plans and study focuses are presented for the issues and various propositions are given [34].

[35] proposed research by using DL based system for recognizing contaminated plants by leaf pictures through TL strategy [36]. This investigation involves NASNet system for the CNN approach. The module is consequently attempted and ready by an uninhibitedly available Plant Village project dataset which involves various pictures of plant leaves with various differentiations in defilement status and region in the plants. By this module, a precision speed of 93.82% was achieved [37-38]. The mark of this study is to chip away at a general designing for perceiving sickness depending on DCNN through TL procedure. In [39], essentially, they collected a dataset which incorporates pictures of 1,014 Betelvine leaves with better and ailing courses of action in the developed betel plant crops and noted actually for getting ready. The Mask RCNN model division module is recognized to perceive fruitful Betelvine undesirable leaves [40].

[41-43] the review executed the inconvenient course of plan and limitation in plant leaf ailment. As to, 3 DL Meta system incorporates Region based RFCN, Single Shot MultiBox Detector (SSD), and Faster Region based RCNN) have been used by the TensorFlow article recognizing plan. Every DL module has been attempted or ready on controllable dataset stage for perceiving plant species affliction [44]. Moreover, improvement in mean typical precision of obviously achieved DL structure is endeavored through state of a art DL analyzer. [45-47] examine TL of DCNN for recognizing plant leaf disease and purposeful by the pre-arranged module gained from gigantic datasets, and later ship of the particular cycle ready by their solitary information [48]. The VGGNet pre-arranged on ImageNet and Inception model is picked in this method. Rather than presenting the planning without any planning by randomly beginning the weight, they start the heap by utilizing pre-arranged network on gigantic stamped dataset and ImageNet [49-50].

[51] proposed a probabilistic programming procedure for recognizing plant disease by state of the art Bayesian DL strategies and vulnerability as misclassification assessment. The outcomes show that Bayesian acceptance achieves classifier effectiveness that resembles the standard streamlining process for tweaking DL modules [52-56]. Meanwhile, the presented methodology evaluates the subsequent thickness for recognizing plant disease challenges and measures the vulnerability of assumptions for test events. [57] in this review, they are relating the capability of ML (SVM, RF, SGD) and DL (VGG-19, VGG-16, Inception-v3) considering citrus plant infection affirmation[58]. The disease CA is gotten by research is engaging as DL approach executes very much appeared differently in relation to other ML moves close [59-60].

[61] encouraged a DL based rice contamination recognizable proof procedure that contains an ML application on cells and cloud servers. The cell application work is to take the rice plant leaf pictures, send them to the cloud server application, and get portrayal results through the data on plant contamination types [61-62]. The outcomes showed that the mobile phone based rice plant sickness acknowledgment application is well limited that is good for recognizing rice plant disease. [63] proposed a viable plan that offers farmers a method to work with appropriate harvest the board. They presented 2 powerful procedures depending on DL technique for perceiving plant disease [64]. The fundamental methodology presents continuous course of action as shown by significant Meta plan and components extractor for perceiving plant sickness and position in the image [65]. The accompanying strategy handles the issues of class imbalance and deceiving positive by presenting a refinement work named Filter Bank [66].

They validate the capability of this philosophy in tomato plant contamination and irritation dataset [67].

III. CONCLUSION

In this study, the research has studied numerous NN methodologies which were used for image processing data with importance on recognizing crop ailments. At first, an examination of data acquisition resources, DL frameworks or techniques, and different image processing methodologies were used for processing the provided imaging data. Subsequently, the research highlighted the results reached from the valuation of numerous current DL systems and finally specified the futuristic feasibility of data analyses. The training of this study is permitting upcoming examinations for learning huge capabilities of DL whenever identifying plant diseases through advancing accuracy and performance of the system.

REFERENCES

[1] Gupta, A., & Namasudra, S. (2022). A novel technique for accelerating live migration in cloud computing. Automated Software Engineering, 29(1), 1-21.

[2] Shankar, K., Perumal, E., Díaz, V. G., Tiwari, P., Gupta, D., Saudagar, A. K. J., & Muhammad, K. (2021). An optimal cascaded recurrent neural network for intelligent COVID-19 detection using Chest X-ray images. Applied Soft Computing, 113, 107878.

[3] Pustokhina, I. V., Pustokhin, D. A., Lydia, E. L., Elhoseny, M., & Shankar, K. (2021). Energy efficient neuro-fuzzy cluster based topology construction with metaheuristic route planning algorithm for unmanned aerial vehicles. Computer Networks, 196, 108214.

[4] Escorcia-Gutierrez, J., Gamarra, M., Beleño, K., Soto, C., & Mansour, R. F. (2022). Intelligent deep learning-enabled autonomous small ship detection and classification model. Computers & Electrical Engineering, 100, 107871.

[5] Shankar, K., Taniar, D., Yang, E., & Yi, O. (2021). Secure and Optimal Secret Sharing Scheme for Color Images. Mathematics, 9(19), 2360.

[6] Pavithran, P., Mathew, S., Namasudra, S., & Srivastava, G. (2022). A novel cryptosystem based on DNA cryptography, hyperchaotic systems and a randomly generated Moore machine for cyber physical systems. Computer Communications, 188, 1-12.

[7] Padmaa, M., Jayasankar, T., Venkatraman, S., Dutta, A. K., Gupta, D., Shamshirband, S., & Rodrigues, J. J. (2022). Oppositional chaos game optimization based clustering with trust based data transmission protocol for intelligent IoT edge systems. Journal of Parallel and Distributed Computing, 164, 142-151.

[8] Kumar, S., Toshniwal, D., & Parida, M. (2017). A comparative analysis of heterogeneity in road accident data using data mining techniques. Evolving systems, 8(2), 147-155.

[9] Dutta, A. K., Aljarallah, N. A., Abirami, T., Sundarrajan, M., Kadry, S., Nam, Y., & Jeong, C. W. (2022). Optimal Deep-Learning-Enabled Intelligent Decision Support System for SARS-CoV-2 Classification. Journal of Healthcare Engineering, 2022.

[10] Lian, J., Jia, W., Zareapoor, M., Zheng, Y., Luo, R., Jain, D. K., & Kumar, N. (2019). Deep-learning-based small surface defect detection via an exaggerated local variation-based generative adversarial network. IEEE Transactions on Industrial Informatics, 16(2), 1343-1351.

[11] Tyagi, S. K. S., Mukherjee, A., Boyang, Q., & Jain, D. K. (2021). Computing resource optimization of big data in optical cloud radio access networked industrial Internet of Things. IEEE Transactions on Industrial Informatics, 17(11), 7734-7742.

[12] Paikrao, P., Mukherjee, A., Jain, D. K., Chatterjee, P., & Alnumay, W. (2021). Smart emotion recognition framework: A secured IOVT perspective. IEEE Consumer Electronics Magazine.

[13] Dutta, A. K. (2021). Detecting phishing websites using machine learning technique. PloS one, 16(10), e0258361.

[14] Manjari, K., Verma, M., Singal, G., & Namasudra, S. (2022). QEST: Quantized and Efficient Scene Text Detector using Deep Learning. Transactions on Asian and Low-Resource Language Information Processing.

[15] Vaiyapuri, T., Dutta, A. K., Punithavathi, I. H., Duraipandy, P., Alotaibi, S. S., Alsolai, H., ... & Mahgoub, H. (2022, April). Intelligent Deep-Learning-Enabled Decision-Making Medical System for Pancreatic Tumor Classification on CT Images. In Healthcare (Vol. 10, No. 4, p. 677). MDPI.

[16] Swati, S., Kumar, M., & Namasudra, S. (2022). Early prediction of cognitive impairments using physiological signal for enhanced socioeconomic

status. Information Processing & Management, 59(2), 102845.

[17] Mansour, R. F., Escorcia-Gutierrez, J., Gamarra, M., Díaz, V. G., Gupta, D., & Kumar, S. (2021). Artificial intelligence with big data analytics-based brain intracranial hemorrhage e-diagnosis using CT images. Neural Computing and Applications, 1-13.

[18] Shankar, K., Perumal, E., Tiwari, P., Shorfuzzaman, M., & Gupta, D. (2021). Deep learning and evolutionary intelligence with fusion-based feature extraction for detection of COVID-19 from chest X-ray images. Multimedia Systems, 1-13.

[19] Agrawal, D., Minocha, S., Namasudra, S., & Gandomi, A. H. (2022). A robust drug recall supply chain management system using hyperledger blockchain ecosystem. Computers in biology and medicine, 140, 105100.

[20] Dutta, A. K., Elhoseny, M., Dahiya, V., & Shankar, K. (2020). An efficient hierarchical clustering protocol for multihop Internet of vehicles communication. Transactions on Emerging Telecommunications Technologies, 31(5), e3690.

[21] Althobaiti, M. M., Almulihi, A., Ashour, A. A., Mansour, R. F., & Gupta, D. (2022). Design of Optimal Deep Learning-Based Pancreatic Tumor and Nontumor Classification Model Using Computed Tomography Scans. Journal of Healthcare Engineering, 2022.

[22] Ismail, S. S., Mansour, R. F., El-Aziz, A., Rasha, M., & Taloba, A. I. (2022). Efficient E-Mail Spam Detection Strategy Using Genetic Decision Tree Processing with NLP Features. Computational Intelligence and Neuroscience, 2022.

[23] Ragab, M., Ashary, E. B., Aljedaibi, W. H., Alzahrani, I. R., Kumar, A., Gupta, D., & Mansour, R. F. (2022). A novel metaheuristics with adaptive neuro-fuzzy inference system for decision making on autonomous unmanned aerial vehicle systems. ISA Transactions.

[24] Alqaralleh, B. A., Vaiyapuri, T., Parvathy, V. S., Gupta, D., Khanna, A., & Shankar, K. (2021). Blockchain-assisted secure image transmission and diagnosis model on Internet of Medical Things Environment. Personal and ubiquitous computing, 1-11.

[25] Das, A. K., Mishra, D., Das, K., Mallick, P. K., Kumar, S., Zymbler, M., & El-Sayed, H. (2022). Prophesying the Short-Term Dynamics of the Crude Oil Future Price by Adopting the Survival of the Fittest Principle of Improved Grey Optimization and Extreme Learning Machine. Mathematics, 10(7), 1121.

[26] Vaiyapuri, T. (2021). Deep learning enabled autoencoder architecture for collaborative filtering recommendation in iot environment. CMC-COMPUTERS MATERIALS & CONTINUA, 68(1), 487-503.

[27] Vaiyapuri, T., Dutta, A. K., Sikkandar, M. Y., Gupta, D., Alouffi, B., Alharbi, A., ... & Kadry, S. (2022). Design of Metaheuristic Optimization-Based Vascular Segmentation Techniques for Photoacoustic Images. Contrast Media & Molecular Imaging, 2022.

[28] Al-Wesabi, F. N., Obayya, M., Hamza, M. A., Alzahrani, J. S., Gupta, D., & Kumar, S. (2022). Energy Aware Resource Optimization using Unified Metaheuristic Optimization Algorithm Allocation for Cloud Computing Environment. Sustainable Computing: Informatics and Systems, 35, 100686.

[29] Nair, R., Ragab, M., Mujallid, O. A., Mohammad, K. A., Mansour, R. F., & Viju, G. K. (2022). Impact of Wireless Sensor Data Mining with Hybrid Deep Learning for Human Activity Recognition. Wireless Communications and Mobile Computing, 2022.

[30] Dutta, A. K. (2020). Managing natural hazards in smart cities in Kingdom of Saudi Arabia using a technique based on interior search algorithm. Electronic Government, an International Journal, 16(1-2), 155-169.

[31] Joshi, G. P., Alenezi, F., Thirumoorthy, G., Dutta, A. K., & You, J. (2021). Ensemble of deep learning-based multimodal remote sensing image classification model on unmanned aerial vehicle networks. Mathematics, 9(22), 2984.

[32] Jain, D. K., Li, Y., Er, M. J., Xin, Q., Gupta, D., & Shankar, K. (2021). Enabling Unmanned Aerial Vehicle Borne Secure Communication with Classification Framework for Industry 5.0. IEEE Transactions on Industrial Informatics.

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

[34] Metawa, N., Nguyen, P. T., Le Hoang Thuy To Nguyen, Q., Elhoseny, M., & Shankar, K. (2021). Internet of things enabled financial crisis prediction in enterprises using optimal feature

subset selection-based classification model. Big Data, 9(5), 331-342.

[35] Shankar, K., Perumal, E., Elhoseny, M., Taher, F., Gupta, B. B., & El-Latif, A. A. A. (2021). Synergic Deep Learning for Smart Health Diagnosis of COVID-19 for Connected Living and Smart Cities. ACM Transactions on Internet Technology (TOIT), 22(3), 1-14.

[36] 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.

[37] 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.

[38] Ragab, M., Alshehri, S., Aldawsari, H. M., Noor, A., Ashary, E. B., Abou-Taleb, S. A. K., & Abdelazim, G. (2022). COVID-19 Identification System Using Transfer Learning Technique With Mobile-NetV2 and Chest X-Ray Images. Frontiers in Public Health, 102.

[39] Zhou, S., Luo, P., Jain, D. K., Lan, X., & Zhang, Y. (2019). Double-domain imaging and adaption for person re-identification. IEEE Access, 7, 103336-103345.

[40] Pustokhina, I. V., Pustokhin, D. A., Aswathy, R. H., Jayasankar, T., Jeyalakshmi, C., Díaz, V. G., & Shankar, K. (2021). Dynamic customer churn prediction strategy for business intelligence using text analytics with evolutionary optimization algorithms. Information Processing & Management, 58(6), 102706.

[41] M. Ragab, E. B. Ashary, M. F. S. Sabir, A. A. Bahaddad and R. F. Mansour, "Mathematical modelling of quantum kernel method for biomedical data analysis," Computers, Materials & Continua, vol. 71, no.3, pp. 5441–5457, 2022.

[42] Sekhar, P., Lydia, E. L., Elhoseny, M., Al-Akaidi, M., Selim, M. M., & Shankar, K. (2021). An effective metaheuristic based node localization technique for wireless sensor networks enabled indoor communication. Physical Communication, 48, 101411.

[43] Ragab, M., Albukhari, A., Alyami, J., & Mansour, R. F. (2022). Ensemble Deep-Learning-Enabled Clinical Decision Support System for Breast Cancer Diagnosis and Classification on Ultrasound Images. Biology, 11(3), 439.

[44] Nair, R., Ragab, M., Mujallid, O. A., Mohammad, K. A., Mansour, R. F., & Viju, G. K. (2022). Impact of Wireless Sensor Data Mining with Hybrid Deep Learning for Human Activity Recognition. Wireless Communications and Mobile Computing, 2022.

[45] Nayak, D. R., Padhy, N., Mallick, P. K., Bagal, D. K., & Kumar, S. (2022). Brain Tumour Classification Using Noble Deep Learning Approach with Parametric Optimization through Metaheuristics Approaches. Computers, 11(1), 10.

[46] Kumar, S., & Nezhurina, M. I. (2019). An ensemble classification approach for prediction of user's next location based on Twitter data. Journal of Ambient Intelligence and Humanized Computing, 10(11), 4503-4513.

[47] Mansour, R. F., Escorcia-Gutierrez, J., Gamarra, M., Gupta, D., Castillo, O., & Kumar, S. (2021). Unsupervised deep learning based variational autoencoder model for COVID-19 diagnosis and classification. Pattern Recognition Letters, 151, 267-274.

[48] Vaiyapuri, T., Lydia, E. L., Sikkandar, M. Y., Díaz, V. G., Pustokhina, I. V., & Pustokhin, D. A. (2021). Internet of Things and Deep Learning Enabled Elderly Fall Detection Model for Smart Homecare. IEEE Access, 9, 113879-113888.

[49] Shankar, K., Mohanty, S. N., Yadav, K., Gopalakrishnan, T., & Elmisery, A. M. (2021). Automated COVID-19 diagnosis and classification using convolutional neural network with fusion based feature extraction model. Cognitive Neurodynamics, 1-14.

[50] Althobaiti, M. M., Kumar, K. P. M., Gupta, D., Kumar, S., & Mansour, R. F. (2021). An intelligent cognitive computing based intrusion detection for industrial cyber-physical systems. Measurement, 186, 110145.

[51] Mukherjee, A., Jain, D. K., Goswami, P., Xin, Q., Yang, L., & Rodrigues, J. J. (2020). Back propagation neural network based cluster head identification in MIMO sensor networks for intelligent transportation systems. IEEE Access, 8, 28524-28532.

[52] Vaiyapuri, T., Mohanty, S. N., Sivaram, M., Pustokhina, I. V., Pustokhin, D. A., & Shankar, K. (2021). Automatic vehicle license plate

recognition using optimal deep learning model. Computers, Materials and Continua, 67(2), 1881-1897.

[53] Jain, D. K., Boyapati, P., Venkatesh, J., & Prakash, M. (2022). An Intelligent Cognitive-Inspired Computing with Big Data Analytics Framework for Sentiment Analysis and Classification. Information Processing & Management, 59(1), 102758.

[54] Jain, D. K., Zareapoor, M., Jain, R., Kathuria, A., & Bachhety, S. (2020). GAN-Poser: an improvised bidirectional GAN model for human motion prediction. Neural Computing and Applications, 32(18), 14579-14591.

[55] Chinnasamy, P., Deepalakshmi, P., Dutta, A. K., You, J., & Joshi, G. P. (2021). Ciphertext-Policy Attribute-Based Encryption for Cloud Storage: Toward Data Privacy and Authentication in AI-Enabled IoT System. Mathematics, 10(1), 68.

[56] Vaiyapuri, T., & Gupta, M. (2021). Traffic accident severity prediction and cognitive analysis using deep learning. Soft Computing, 1-13.

[57] M. Ragab, A. Algarni, A. A. Bahaddad and R. F. Mansour, "Machine learning applied to problem-solving in medical applications," Computers, Materials & Continua, vol. 69, no.2, pp. 2277–2294, 2021.

[58] Namasudra, S. (2020). Fast and secure data accessing by using DNA computing for the cloud environment. IEEE Transactions on Services Computing.

[59] Mukherjee, A., Jain, D. K., & Yang, L. (2020). On-demand efficient clustering for next generation IoT applications: A hybrid NN approach. IEEE Sensors Journal, 21(22), 25457-25464.

[60] A. A. Eshmawi, H. Alhumyani, S. A. Khalek, R. A. Saeed, M. Ragab et al., "Design of automated opinion mining model using optimized fuzzy neural network," Computers, Materials & Continua, vol. 71, no.2, pp. 2543–2557, 2022.

[61] Sharma, P., Moparthi, N. R., Namasudra, S., Shanmuganathan, V., & Hsu, C. H. (2021). Blockchain-based IoT architecture to secure healthcare system using identity-based encryption. Expert Systems, e12915.

[62] Namasudra, S., Sharma, P., Crespo, R. G., & Shanmuganathan, V. (2022). Blockchain-Based Medical Certificate Generation and Verification for IoT-based Healthcare Systems. IEEE Consumer Electronics Magazine.

[63] Lan, X., Zhang, W., Zhang, S., Jain, D. K., & Zhou, H. (2019). Robust multi-modality anchor graph-based label prediction for RGB-infrared tracking. IEEE Transactions on Industrial Informatics.

[64] 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.

[65] Ragab, M., Eljaaly, K., Alhakamy, N. A., Alhadrami, H. A., Bahaddad, A. A., Abo-Dahab, S. M., & Khalil, E. M. (2021). Deep ensemble model for COVID-19 diagnosis and classification using chest CT images. Biology, 11(1), 43.

[66] Jain, D. K., Tyagi, S. K. K. S., Neelakandan, S., Prakash, M., & Natrayan, L. (2021). Metaheuristic optimization-based resource allocation technique for cybertwin-driven 6G on IoE environment. IEEE Transactions on Industrial Informatics.

[67] Mansour, R. F., El Amraoui, A., Nouaouri, I., Díaz, V. G., Gupta, D., & Kumar, S. (2021). Artificial intelligence and Internet of Things enabled disease diagnosis model for smart healthcare systems. IEEE Access, 9, 45137-45146.