Bulletin of Electrical Engineering and Informatics
Vol. 11, No. 4, August 2022, pp. 2273~2279
ISSN: 2302-9285, DOI: 10.11591/eei.v11i4.3290

Classification of covid patient image dataset using modified deep convolutional neural network system

Manjunathan Alagarsamy[1], Karthikram Anbalagan[2], Yuvaraja Thangavel[3], Jeevitha Sakkarai[4], Jenopaul Pauliah[5], Kannadhasan Suriyan[6]
[1]Department of Electronics and Communication Engineering, K. Ramakrishnan College of Technology Trichy, Tamilnadu, India
[2]Department of Computer Science and Engineering, Vel Tech Rangarajan Dr. Sagunthala R & D Institute of Science and Technology, Chennai, Tamilnadu, India
[3]Department of Electronics and Communication Engineering, Kongunadu College of Engineering and Technology, Trichy, Tamilnadu, India
[4]Department of Computer Science and Information Technology, Kalasalingam Academy of Research and Education, Krishnankoil, Tamilnadu, India
[5]Department of Electrical and Electronics Engineering, Adi Shankara Institute of Engineering and Technology, Kalady, Kerala, India
[6]Department of Electronics and Communication Engineering, Cheran College of Engineering, Karur, Tamilnadu, India

Article Info

Article history:

Received Jan 6, 2022
Revised Apr 14, 2022
Accepted Jun 19, 2022

Keywords:

Convolutional neural networks
Covid
CT scan images
Disease prediction

ABSTRACT

The number of people infected with the corona virus is steadily rising. Even after being treated and returned to normality, many who were impacted are still suffering from a variety of health problems. We suggest a new, more effective approach to dealing with this issue, as well as putting in place preventative measures to prevent the spread of disease. The modified convolutional neural networks (M-CNN) architecture is modified deepCNN architecture. Using existingcorona virus disease 2019 (COVID-19) computerized tomographyscan (CT scan) images, this suggested approach intends to develop a deep model for screening and forecasting the risk of disease propagation. The suggested model was trained using 1000 scan pictures from various sources, yielding a prediction accuracy of 93 percent, which is much greater than previous methods.

Corresponding Author:

Manjunathan Alagarsamy
Department of Electronics and Communication Engineering
K. Ramakrishnan College of Technology Trichy
Tamilnadu, India
Email: manjunathankrct@gmail.com

1. INTRODUCTION

On March 11, 2020, all nations notified the World Health Organization (WHO) in Geneva about a corona virus disease 2019 (COVID-19) epidemic discovered in Wuhan, China [1]. The virus that causes this illness is SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), and 2020 has been classified as a worldwide COVID-19 pandemic year. As of December 2020, the WHO recorded 62,844,837 confirmed cases worldwide, with 1,465,144 fatalities [2]. COVID-19 has claimed many lives across the globe, however some infected persons have only minor to moderate symptoms and recover without needing to be hospitalised [3]. COVID-19 viruses are disseminated by droplets produced by infected people's coughs and sneezes.The majority of these viruses transmit via the air, causing them to spread quickly. Fever, dry cough, breathing issues, allergies, skin rashes, and a loss of smell are all indications of this illness. Positivity for COVID-19 [4]. According to the WHO study, COVID-19 medications or prophylactic vaccines are currently in the research and testing stage. Taking the necessary steps to protect ourselves will only help to prevent the disease's spread. Clinical research is used to make predictions and diagnosis [5]. Despite significant advances in medical science and technology, as well as a vast array of medical equipment and smart devices for monitoring health conditions, COVID-19 disease prediction using rontgen (X-ray) or chest CT scan images faces numerous complex challenges in terms of image segmentation and recognition.

Artificial Intelligence has seen a significant increase in the creation and training of machine learning and deep learning models that are similar to human cognitive capabilities. Using deep neural models, researchers were able to get excellent results in object recognition and tracking using computer vision techniques [6]. Deep learning algorithms have made significant advances in image and video recognition since their debut. The image or video data is processed directly by the deep neural network, bypassing standard image processing methods and procedures. The research into neural networks yielded previously unimaginable visual prediction outcomes [7]. The convolutional neural network (ConvNet/CNN) is a well-known deep learning technique for image categorization. By immediately evaluating the photos, CNN was able to get great results in image recognition difficulties. CNN needed fewer pre-processing steps and was able to rapidly learn the scan pictures' primary features.

The use of neural networks in deep learning is well-known in the field of computer vision, and it has a significant influence on benchmark datasets [8]. CNN has the second-best decreased error rate for an image classification assignment, according to the ImageNet Challenge, which was conducted in 2012. The CNN design has changed the trend of swiftly recognising natural photos without the need of complicated algorithms. The ConvNet design effectively mimics the Visual Cortex, a human brain mechanism, by using the neural network layer. CNN models are especially good at gathering spatial and temporal information when employing filter features, and they can quickly fit the pictures for processing by reusing the weights obtained after each stacking step [9]. The convolution layer, also known as the kernel or filter, walks through the whole picture to perform convolution operations. This approach looks for aspects like edges and colour in an image [10]. Padding methods might be developed to improve a picture's dimensionality. The spatial data's dimensionality is reduced by the pooling layer that follows. The output layer is coupled to all of the preceding connecting nodes through completely linked layers, and the Softmax layer provides probability-based prediction outputs [11].

2. RELATED WORKS

Researchers are concentrating their efforts in the wake of the COVID-19 epidemic on creating deep models that can detect and forecast COVID-19 in X-ray and CT scan pictures. According to WHO estimates, the illness affects 10% of the world's population [12]. Millions of individuals were impacted, and the majority of them had physical and health problems, with some even dying as a result. As a result, governments, clinicians, and academic institutions have prioritised screening and treatment [13]. Clinical studies have paid specific attention to CT scans and chest X-ray pictures. A great deal of study has gone into determining what obstacles clinicians encounter in preventing COVID-19 infection [14]. The goal of this study is to create and deploy a COVID-19 end-to-end prediction system that will make treatment recommendations easier for physicians.Using CT scans and chest X-ray pictures, a large number of COVID-19 datasets (see Table 1) were developed for research reasons. Despite the widespread usage of deep models and a large increase in the number of applications [15]-[17], the analysis of these pictures has received little attention. The proposed modified deep CNN model has an unimaginable quantity of information with the prediction system. The several available models suggest that the lack of attention on medical picture recognition should be reconsidered [18]. As a result, the emphasis of this study is on the identification of medical imagery.

Because CT scan pictures provide reliable and precise findings at a reasonable cost, they are an effective tool to predict COVID-19. The proposed model examines a variety of images from the COVID-19 dataset, which are shown in Table 1, including CT scan photographs of both positive and negative COVID-19 classes [19]-[21], in order to focus research efforts on COVID-19 prediction in real-world situations. By analysing the spatial properties of photographs, we were able to teach our system to identify patterns in the incidence of illness. COVID-19 illness compliance was automatically classified and forecasted using the supplied model [22]. The following is a collection of COVID-19 datasets that are freely accessible on the internet for image analysis and recognition research.

In the process of processing the scan photos, medical image recognition systems, which are primarily concerned with diagnosing illness or forecasting the potential of infection, take on the function of the physician [23]. A medical image analysis (MIA) system is what this system is called. In addition, the suggested technique aids in the acquisition of intuitive knowledge about a variety of disease picture analysis and identification approaches. Clinicians might utilise this software model to recognise illness patterns, determine the core cause of disease, and propose therapy options. To realise the ramifications of deep models, the expert must first understand the model [24]-[25]. The study's major goal is to examine a huge number of photos of various illnesses in order to develop a model that can be compared to human intellect. Although these models are reliable and accurate, they have the overhead required to handle a broad variety of scan pictures, including tomography, nasal endoscopy, CBCT scans, RBC nuclear scans, and other materials [26]. Deep learning algorithms, on the other hand, lighten the burden by eliminating the need for time-consuming pre-processing, giving the user greater control than typical machine learning-based systems. The proposed approach is based on studies of many deep learning algorithms for recognising COVID-19 in medical photos [27]. This study focuses on a real-time medical diagnosis system based on the COVID-19 scan image recognition technology. Using modified deep CNN, the proposed system will anticipate COVID-19 disease [28]. To assist radiologists in diagnosing COVID-19 based on X-ray imaging data, Hemdan introduced the COVIDX-Net model [29]. Using the datasets CUB-Birds, fine-grained visual categorization (FGVC-Aircraft), and Stanford-Cars, the author proposed an attention-based CNN model for picture identification. To identify the illness, [30] suggested utilising Deep CNN Techniques. COVID-19 was discovered on CT scans in the thorax.

Table 1. Summary of various COVID-19 datasets

Dataset	File Size	Number of CT Scan Images	Publicly Available
COVID19-CT dataset	95 MB	349	Yes
COVID-CT-Dataset	86MB	275	Yes
COVID-19 CT scans	1 GB	20	Yes
Novel Corona Virus 2019 Dataset	20.68 MB	Daily updated	Yes
Open Research Dataset for COVID-19 (CORD-19)	6 GB	Full text	Yes
The complete Our World in Data COVID-19 dataset	Daily Updated		Yes
CT-scan Dataset SARS-COV-2	2482		Yes
COVID-19 Lung CT Scans	86 MB	275	Yes
Extensive X-Ray images and CT Chest images Dataset	4 GB	Totally 17099 X-ray and CT images.	Yes
COVID-19 CT Segmentation Dataset	1.1 GB	20	Yes
SIRM chest X-rays and CT images	1 GB	68	No

3. SYSTEM ARCHITECTURE

This strategy focuses on combining data for prediction using a decision fusion-based method. A variety of deep learning techniques to predict the presence of COVID-19 in CT scan pictures [31]. The performance of this model, which contains 618 CT data from male patients of varied ages, was evaluated using the Noisy-OR Bayesian function. Deep models are used to monitor contaminated areas, and their performance was evaluated using the Noisy-OR Bayesian function, which produced an accuracy of 86.7 percent. Using 3D deep CNN techniques and chest CT segments, the model to identify COVID-19 [8]. Built a COVID-19 prediction system using chest X-ray images [13]. To help in the early identification of COVID-19 probable sites in CT scan pictures, built a variety of CNN models [9]. The CIFAR-10) dataset from the Canadian Institute for Advanced Research to study the Transfer learning technique for CNN image classification, specifically for the inception-v3 model, in order to assess the recognition accuracy of the trained model [32]. The current attention convolutional neural network (RA-CNN) model introduced [33] uses attention-based approaches to recognise pictures instead of bounding boxes and annotations. Figure 1 (see in appendix) shows a collection of interstitial lung disease (ILD) high-resolution computed tomography (HRCT) pictures with comments based on this model.

4. RESULTS AND DISCUSSION

The results of our suggested modified deep CNN model's experimental assessment are summarised below. The suggested design employs 16 Convolution layers, four Pooling layers for average pooling, and two completely connected layers at the end for convolution. The Softmax layers use the output of fully linked layers to determine the class of a given input picture. Figure 2 shows how batch normalisation layers were introduced in the middle to speed up the model's training. To improve non-linearity in input pictures, the rectified linear unit (ReLU) activation function is applied. The results of the suggested method on a variety of COVID-19 chest CT scan image datasets are shown in Table 1. The model's accuracy demonstrates its remarkable picture recognition capabilities. We quantified the suggested end-to-end model in terms of segmentation, labelling, and discovering contaminated zones. The performance of the M-CNN model was tested and examined using the loss function during training and testing, and the performance was enhanced utilising the attention mechanism and regularisation. The graphs below show the performance of the M-CNN model during training and testing. Figures 3, 4, 5 depict the M-CNN Model's training and testing accuracy.

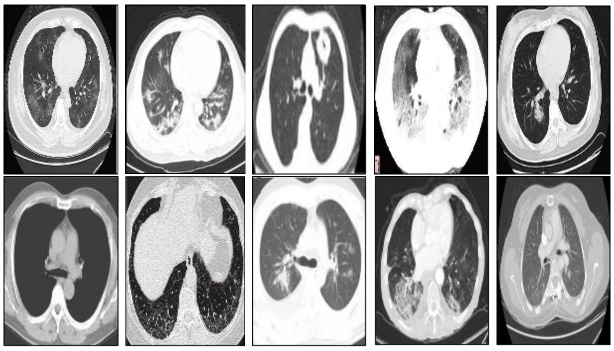

Figure 2. Segmentation

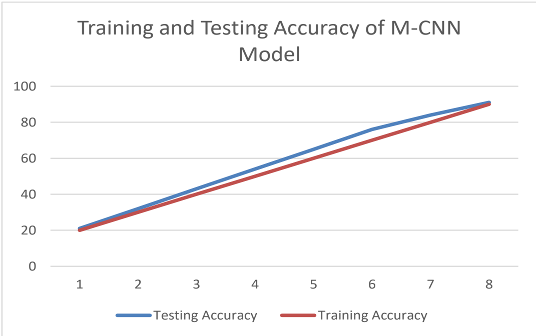

Figure 3. M-CNN model

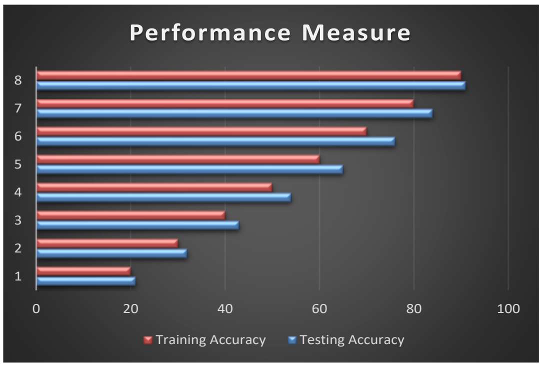

Figure 4. M-CNN model performance measure

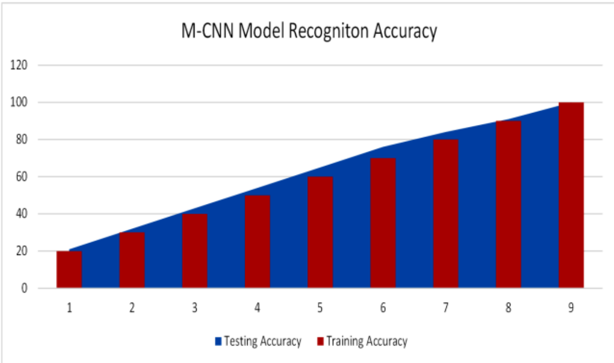

Figure 5. M-CNN model recognitonaccuracy

5. CONCLUSION AND FUTURE WORK

Using a deep learning method, the suggested M-DCNN model achieved substantial performance in the image recognition system. Medical practitioners may establish the aetiology of COVID-19 disease and execute therapeutic activities using the offered model and a set of CT scan photos. Increased prediction outputs boost the model's picture recognition efficiency. Patients with COVID-19 and their families may encounter physical and mental health issues. To get around this, many scholars have offered a variety of prediction and diagnostic methods. The suggested innovative M-CNN Model was created with the goal of reducing recognition error and providing consistent performance. The experimental findings show that our suggested model is effective during training and testing. Our next effort will be to develop a model for recognising various types of medical photos in order to predict illness using a number of characteristics that give reliable findings. The purpose of this strategy was to take the load of analysing 10 COVID-19 CT scan pictures off of doctors and radiologists. The proposed deep model also makes it easier and faster to locate COVID-19 positive occurrences with little effort. Finally, the suggested M-CNN model might be utilised to predict cancer, allergy, and asthma pictures, as well as images of liver illness.

APPENDIX

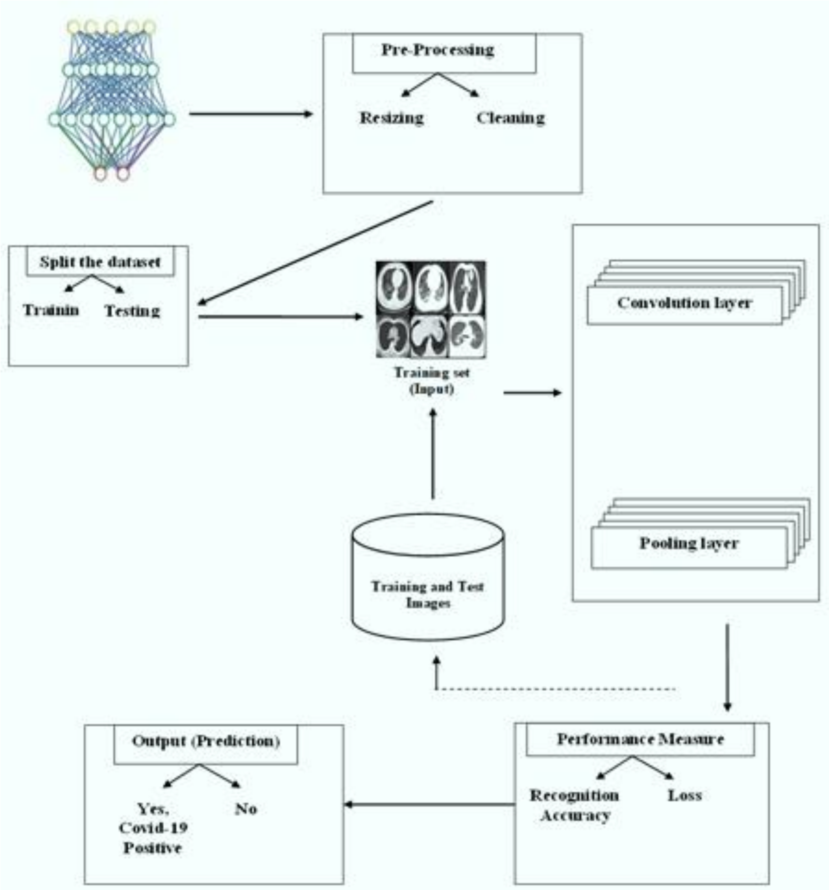

Figure 1. Proposed M-CNN system architecture

REFERENCES

[1] D. Shen, G. Wu, and H-I. Suk, "Deep learning in medical image analysis," *Annual review of biomedical engineering*, vol. 19, pp. 221-248, 2017, doi: 10.1146/annurev-bioeng-071516-044442.

[2] A. Krizhevsky, I. Sutskever, and G. E. Hinton, "Imagenet classification with deep convolutional neural networks,"*Communications of the ACM*, vol. 60, no. 6, pp. 84-90, 2017, doi: 10.1145/3065386.

[3] J. Ker, L. Wang, J. Rao and T. Lim, "Deep Learning Applications in Medical Image Analysis," in *IEEE Access*, vol. 6, pp. 9375-9389, 2018, doi: 10.1109/ACCESS.2017.2788044.

[4] S. Albawi, T. A. Mohammed and S. Al-Zawi, "Understanding of a convolutional neural network," *2017 International Conference on Engineering and Technology (ICET)*, 2017, pp. 1-6, doi: 10.1109/ICEngTechnol.2017.8308186.

[5] M. I. Razzak, S. Naz, and A. Zaib, "Deep learning for medical image processing: Overview, challenges and the future," In *Classification in BioApps*, pp. 323-350,2018, doi: 10.1007/978-3-319-65981-7_12.

[6] G. Wang *et al.*, "Interactive Medical Image Segmentation Using Deep Learning With Image-Specific Fine Tuning," in *IEEE Transactions on Medical Imaging*, vol. 37, no. 7, pp. 1562-1573, July 2018, doi: 10.1109/TMI.2018.2791721.

[7] H. R. Roth*etal*.,"Deep learning and its application to medical image segmentation," *Medical Imaging Technology*, vol. 36, no.2, 2018, pp. 63-71, doi: 10.11409/mit.36.63.

[8] A. M. C. Antioquia, D. S. Tan, A. Azcarraga, W. -H. Cheng and K. -L. Hua, "ZipNet: ZFNet-level Accuracy with 48× Fewer Parameters," *2018 IEEE Visual Communications and Image Processing (VCIP)*, 2018, pp. 1-4, doi: 10.1109/VCIP.2018.8698672.

[9] M. Hussain, J. J. Bird, and D. R. Faria, "A study on cnn transfer learning for image classification," In *UK Workshop on Computational Intelligence*, pp. 191-202,2018, doi: 10.1007/978-3-319-97982-3_16.

[10] N. Chen*et al*., “Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study," *The Lancet*, vol. 395, no. 10223, 2020, pp. 507-513, doi: 10.1016/S0140-6736(20)30211-7.

[11] M. H. Hesamian, W. Jia, X. He, and P. Kennedy, "Deep learning techniques for medical image segmentation: Achievements and challenges," *Journal of digital imaging*, vol. 32, no. 8, 2019, pp. 582-596, doi: 10.1007/s10278-019-00227-x.

[12] A. Fourcade and R. H. Khonsari, "Deep learning in medical image analysis: A third eye for doctors,"*Journal of stomatology, oral and maxilla of acial surgery*, vol.120, no. 4, pp. 279-288, 2019, doi: 10.1016/j.jormas.2019.06.002.

[13] P. S. Rajan andL.Kavitha, “Automated retinal imaging system for detecting cardiac abnormalities using cup to disc ratio,” *Indian Journal of Public Health Research & Development*, vol. 10, no. 2, pp.1019-1024, Mar. 2019, doi:10.5958/0976-5506.2019.00430.3.

[14] C. Bhuvaneshwari and M. Alagarsamy, “Advanced gesture recognition system using long-term recurrent convolution network,” *Materials Today Proceedings,* vol. 21, no. 7, 2020, pp.731-733, doi: 10.1016/j.matpr.2019.06.748.

[15] E. E. D. Hemdan, M. A. Shouman, and M. E. Karar, "Covidx-net: A framework of deep learning classifiers to diagnose covid-19 in x-ray images," *Biomedical Image Analysis*,2020, doi: 10.48550/arXiv.2003.11055.

[16] S. Long, X. He, and C. Yao, "Scene text detection and recognition: The deep learning era," *International Journal of Computer Vision*, pp. 1-24, 2020, doi: 10.48550/arXiv.1811.04256.

[17] H. X. Bai *et al*.,"Performance of radiologists in differentiating COVID-19 from non-COVID-19 Viral Pneumonia at Chest CT,"*Radiology*, vol. 296, no. 2, pp. E46-E54, 2020, doi: 10.1148/radiol.2020200823.

[18] X. He*et al*., "Sample-Efficient Deep Learning for COVID-19 Diagnosis Based on CT Scans,"*medRxiv*, 2020, doi: 10.1101/2020.04.13.20063941.

[19] J. Zhao, Y. Zhang, X. He, X. Yang, S. Zhang, and P. Xie, "COVID-CT-Dataset: a CT scan dataset about COVID- 19,"*arXiv preprint arXiv2003.13865*, 2020, doi: 10.48550/arXiv.2003.13865.

[20] D. -P. Fan *et al*., "Inf-Net: Automatic COVID-19 Lung Infection Segmentation from CT Images," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 8, pp. 2626-2637, Aug. 2020, doi: 10.1109/TMI.2020.2996645.

[21] J. Ma *et al*., "Towards Efficient COVID-19 CT Annotation: A Benchmark for Lung and Infection Segmentation,"*arXiv preprint arXiv2004.12537*, vol. 48, no. 3, (2020), doi: 10.1002/mp.14676.

[22] X. Xu *et al*., "A deep learning system to screen novel coronavirus disease 2019 pneumonia," *Engineering*, vol. 6, no. 10, pp. 1122-1129, 2020, doi: 10.1016/j.eng.2020.04.010.

[23] Y. Fang *et al*., "Sensitivity of chest CT for COVID-19: comparison to RT-PCR," *Radiology*, vol. 29, no. 2, pp. E115-E117, doi: 10.1148/radiol.2020200432.

[24] Y. Song *et al*., "Deep Learning Enables Accurate Diagnosis of Novel Coronavirus (COVID-19) With CT Images," in *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, vol. 18, no. 6, pp. 2775-2780, 1 Nov.-Dec. 2021, doi: 10.1109/TCBB.2021.3065361.

[25] S. Wang *et al*., "A deep learning algorithm using CT images to screen for Corona Virus Disease (COVID19)," *European Radiology*, vol. 31, pp. 6096–6104, 2021, doi: 10.1007/s00330-021-07715-1.

[26] A. K. Mishra, S. K. Das, P. Roy, and S. Bandyopadhyay, “Identifying COVID19 from Chest CT Images: A deep Convolutional Neural Networks Based Approac,” *Journal of Healthcare Engineering*,2020, doi: 10.1155/2020/8843664.

[27] R. Muthukrishnan, C. G. Babu, M. Alagarsamy, S Udhayanan, R. S. Kumar, and M. Mathankumar, “A Graphical User Interface Based Heart Rate Monitoring Process and Detection of PQRST Peaks from ECG Signal,” *Lecture Notes in Networks and Systems*, pp. 481–496, 2021, doi: 10.1007/978-981-33-4305-4_36.

[28] R. Muthukrishnan, C. G. Babu, K. Kumar, D. Hepsiba, A. Manjunathan, and R. S. Kumar, “ECG Cardiac arrhythmias Classification using DWT, ICA and MLP Neural Network,”*Journal of Physics: Conference Series*, vol.1831, no.1, p.012015, 2021, doi: 10.1088/1742-6596/1831/1/012015.

[29] C. Bhuvaneshwari and A. Manjunathan, “Reimbursement of sensor nodes and path optimization,” *Materials Today: Proceedings*, vol. 45, no. 2, pp.1547-1551, doi: 10.1016/j.matpr.2020.08.193.

[30] A. S. JoyandR. Ravi, “Smart Card Authentication Model based on Elliptic curve Cryptography in IoT Networks,” *International Journal of Electronic Security and Digital Forensics*, vol. 13, no. 5, 2021, pp.548-569, doi: 10.1504/IJESDF.2021.117314.

[31] S. Kannadhasan, G. KarthiKeyan and V. Sethupathi, "A graph theory based energy efficient clustering techniques in wireless sensor networks," *2013 IEEE Conference on Information & Communication Technologies*, 2013, pp. 151-155, doi: 10.1109/CICT.2013.6558080.

[32] S. Surya and R. Ravi, "Concoction Node Fault Discovery (CNFD) on Wireless Sensor Network UsingtheNeighborhoodDensityEstimationinSHM,"*Wireless Personal Communication*, vol. 113, no. 4, 2020, pp. 2723–2746, doi: 10.1007/s11277-020-07623-5.

[33] E. R. S, and R. Ravi, “A performance analysis of Software Defined Network based preventionon phishing attack in cyberspace using a deep machine learning with CANTINA approach (DMLCA),” *Computer communications*, *Elseiver*,vol. 153,no. 1, 2020, pp.375-381, doi: 10.1016/j.comcom.2019.11.047.

BIOGRAPHIES OF AUTHORS

Manjunathan Alagarsamy received the Engineer degree in Electronics and Comunication Engineering from Dr.Navalar Nedunchezhiyan College of Engineering in 2010.He received the Master degree in Embedded System Technologies from Raja College of Engineering and Technology, Madurai, Tamilnadu, India in 2013.He is currently working as an Assistant Professor in the Department of Electronics and Communication Engineering at K.Ramakrishnan College of Technology, Trichy, India. His area of interests includes embedded systems, image processing, sensors and interfacing networks and internet of things. He has published 13 article in peer reviewed International journals and presented 6 papers in International conferences. He can be contacted at email: manjunathankrct@gmail.com

Karthikram Anbalagan received Bachelor of Technologyin Information Technology from Shri Angalamman College of Engineering &Technology in 2008. He received the Master degree in Information Technology from Bharathidasan University, Tiruchirapalli in 2012. He is currently working as an Assistant Professor in the Department of Computer Science & Engineering at Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, India. His research interests are big data, machine learning and sensor data analytics. He has published 2 articles in international journals and presented 3 papers in international conference. He can be reached at email: karthikram86@gmail.com

Yuvaraja Thangavel received the B.E degree in Electronics and Comunication Engineering from Sona College of Technology, Salem in 2005.He received the M.E degree in Applied Electronics from Kongu Engineering College, Erode, in 2008. He received the Ph.D. degree in Faculty of nformation and Communication Engineerng from Anna University, Chennai in 2020. He is currently working as an Associate Professor in the Department of Electronics and Communication Engineering at Kongunadu College of Engineering and Technology, Trichy, Tamilnadu, India. His area of interests includes Image processing, Signal Processing, Steganography and Internet of Things. He has published 10 article in peer reviewed International journals and presented 7 papers in International conferences. He can be contacted at email: kstyuvaraja@gmail.com.

Jeevitha Sakkarai received the M. Tech (Computer Applications) degree from Kalasalingam University in the year of 2010. She received the M.Sc (Computer Science) degree from SRM Arts & Science under University of Madras, Chennai, Tamil Nadu, India, in 2004 and received the B.Sc (Computer Science) from Prof. Dhanabalan Arts & Science College, Tamil Nadu, India in the year of 2002. She worked as an Assistant Professor in the Department of Computer Science and Engineering, Kalasalingam Institute of Technology, Srivilliputhur, Tamil Nadu, from July 2010- November 2021. Currently, she is working as an Assistant Professor in the Department of Computer Science and Information Technology, Kalasalingam Academy of Research and Education from Nov 2021. She is having more than 13 years' of experience in the field of teaching. Her research interests include image processing, data mining and data analytics. She can be contacted at email: jeevitha.ramkumar@gmail.com

Jenopaul Pauliah received his B.E degree in Electrical and Electronics Engineering from Manonmaniam Sundaranar University, Thirunelveli in 2003. He completed his Master's in Business of Administration from Annamalai University Chidambaram in the year of 2005. He completed his Master of Engineering in Anna University in the year 2007. In 2009 he joined as a full-time research scholar at Noorul Islam centre for higher education tamil nadu. His researches focus on power quality, FACTS, and image processing wireless networks. He has published 105 research papers in various International journals including 22 IEEE International conferences 5 sci indexed journal papers. He received few funded projects, 2 consultancy works, applied for 16 patents with 3 granted and 6 book chapters. He is the reviewer of IEEE power electronics, Elsevier publication European Transactions on Electrical Power Manuscript Electric Power Components and System. Journal Taylor and Francis Transaction on Industrial Electronics IEEE International Transactions on Electrical Energy Systems. Wiley publication. He can be contacted at email: jeno.eee@adishankara.ac.in.

Dr. S. Kannadhasan is working as an Associate Professor in the department of Electronics and Communication Engineering in Cheran College of Engineering, karur, Tamilnadu, India. He is Completed the Ph.D in the field of Smart Antenna for Anna University in 2022. He is Twelve years of teaching and research experience. He obtained his B.E in ECE from Sethu Institute of Technology, Kariapatti in 2009 and M.E in Communication Systems from Velammal College of Engineering and Technology, Madurai in 2013. He obtained his M.B.A in Human Resources Management from Tamilnadu Open University, Chennai. He has published around 45 papers in the reputed indexed international journals indexed by SCI, Scopus, Web of science, Major indexing and more than 146 papers presented/published in national, international journal and conferences. Besides he has contributed a book chapter also. He also serves as a board member, reviewer, speaker, session chair, advisory and technical committee of various colleges and conferences. He is also to attend the various workshop, seminar, conferences, faculty development programme, STTP and Online courses. His areas of interest are smart antennas, digital signal processing, wireless communication, wireless networks, embedded system, network security, optical communication, microwave antennas, electromagnetic compatability and interference, wireless sensor networks, digital image processing, satellite communication, cognitive radio design and soft computing techniques. He is Member of IEEE, ISTE, IEI, IETE, CSI, IAENG, SEEE, IEAE, INSC, IARDO, ISRPM, IACSIT, ICSES, SPG, SDIWC, IJSPR and EAI Community. He can be contacted at email: Kannadhasan.ece@gmail.com.