Deep learning based recognition of wearing mask in public during pandemic

Dr.L.Malathi, ASP/CSE,

Vivekanandha College of Engineering for Women, Tiruchengode-637211,

Namakkal malathi@vcew.ac.in

Dr.Ravindra Mersing Ghoti

Head and Associate Professor Department of Psychology

Shivaji Art's, commerce and science College Kannad,

District Aurangabad Maharashtra India 431103

ghotirm@shivajicollegekannad.org

Dr. Swapnaja R.More

Bharati Vidyapeeth,Pune

swapnaja86@gmail.com

Dr Melanie Elizabeth Lourens

Deputy Dean, Faculty of Management Sciences

Durban University of Technology

Durban, KwaZulu-Natal , South Africa

Melaniel@dut.ac.za

Orcid number: 0000-0002-4288-8277

Dr Prateek Bhanti

School of engineering and technology

Mody University, Lakshmangarh,Sikar, Rajasthan

prateek bhanti.cet@modyuniversity.ac.in

Dr Sanjeev Patwa

School of engineering and technology

Mody University, Lakshmangarh,Sikar,Rajasthan

sanjeevpatwa.cet@modyuniversity.ac.in

Abstract

Human face detection is a computer vision application. Face image processing has been the subject of various studies. Several researchers have previously investigated facial recognition. We used IOT and AI algorithms with the basic notion of human face identification in this research to identify the covid-19 patient travelling in public locations during isolation period. -19 criteria for Human face discovery is the novel notion in this covid. An Internet of Things (IoT) method is used to store daily averages of 19 positive cases across districts. The information that can be stored, such as a person's name, phone number, and address (with different poses). Personal information is securely saved in the cloud database and can be accessed at any time by logging into your account. IoT and Raspberry Pi are used to store and retrieve data. Face detection technology in CCTV cameras is used to keep tabs on the current scenario and identify any people who might be in the video. We installed cameras in strategic locations and linked them to the cloud server so that the faces of those with and those without covid 19 could be forwarded. hange detection methodologies in remotely sensed images suffer from the problem of data inadequacy; and to handle this problem, semi-supervised approaches can be opted. Semi-supervised Modified Self-organizing Feature Map is used to classify covid positive and normal cases in this recognition method. Every time a person's face is taken by the camera and compared to a database, an AI algorithm is used to identify and categorise the person (testing centre data). Covid positive patients will be flagged by an AI system, and their personal data will be sent to a government health care unit, which may take legal action against them, in this classification process. OpenCV and the Python platform were used to carry out this experiment. Public exposure to covid 19 will be reduced, and mortality rates owing to covid illness will be reduced as a result of this proposed model.

Keyword: Raspberry pi, Semi-supervised Modified Self-organizing Feature Map, COVID-19, Face recognition and acknowledgement.

Number: 10.14704/nq.2022.20.7.NQ33346 **Neuro Quantology 2022; 20(7):2691-2701**

1 Introduction

Sneezing and coughing are the primary means of transmitting COVID-19. Breathing droplets can be formed when living, however they are not planned to fly through the atmosphere. By way of fomite transfer, it could spread [1]. The pathogen can enter the body through the mouth, nose, or eyes after coming into touch with a fomite (infected surface). This is why it's so important to wash your hands thoroughly and frequently. [2]. has a surface survival time of up to 72 hours. It might take anywhere from two to fourteen days for symptoms to begin, with a five-day average. As the virus spreads worldwide, the international community is exploring new ways to stop it [3]. Within six feet, the virus spreads rapidly among persons who have been in close contact for a long amount of time. The use of real-time scheduling and optimization algorithms can help keep crowds from forming in specific locations (such as supermarkets or hospitals) while still providing a high Quality-of-Service standard despite the social distance between users [4]. As shown in Figure 1, scheduling and optimization strategies can be used to meet a variety of social distance circumstances.

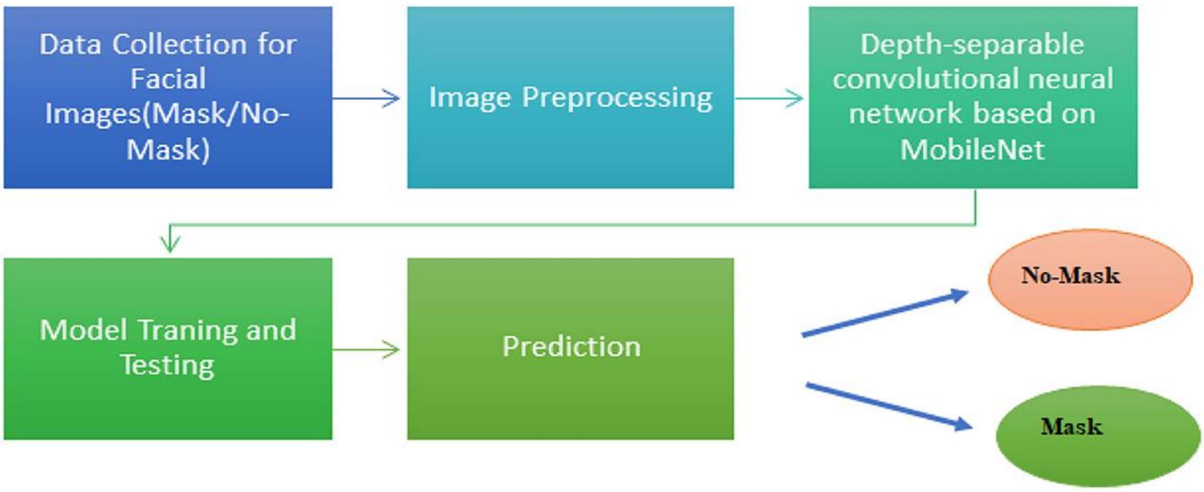

Figure 1: several social distancing scenarios for Scheduling and optimization

It is possible for an infected person to spread their illness to others by coughing or sneezing into the air. Lung cells begin to be damaged as soon as they come into contact with the droplets. Those who are afflicted with the virus but show no symptoms help transmit it, according to a recent study [5]. This means that even if you don't see any symptoms, you should keep a distance of at least 6 feet from other individuals. Viral spread can be prevented by decreasing human contact in public locations, avoiding crowds, and maintaining a suitable distance between persons [6]. Social distancing is linked to these efforts. All of these technologies have shown encouraging results in a variety of real-world scenarios during the past two decades. The advancements in artificial intelligence have made facial recognition tasks increasingly accurate. Detection of human faces is a subfield of computer vision. Regardless of the size, position, or state of an image, the goal of face detection is to identify and locate a human face in it [6 and 7].

In a variety of fields, face recognition is becoming increasingly significant, including security, industrial control, and the presence system [8]. It is most contagious when people are unwell, although outbreaks can occur even before symptoms emerge [8]. COVID-19 can remain on a surface for up to 72 hours. A median of five days elapses between exposure and the onset of symptoms. Sneezes and coughs should be covered with tissues or elbows, and filthy hands should be kept away from the face [9]. Recent advances in artificial intelligence (AI) in computer vision have made it possible for computers to correctly recognise and classify people [10].

2 Literature survey

To solve the issue of video frame temporal alignment is used, [11] As a means of displaying motion, the researchers Xue et al. [12] used a flow image to represent the task-oriented flow. Video deblurring does not require precise temporal alignment anymore according to a deep learning algorithm described by Su et al. [13]. The context layers into the detection modules has been proposed by Najibi et al. [14]. Real-time is crucial when using detectors in real systems.

The proposed method using AI-based algorithms to limit physical contacts between people. To assess the dangers of large crowds in public locations, researchers employ simulated and real-world data collected via bipartite graph and Hopcroft-Karp network approaches. To begin, a graph of the data is created, and the graph's nodes and links are identified. In the Hopcroft-Karp approach, the bipartite graph is reconstructed. We've discovered an enormous number of pairs of matched sets and drivers. Last but not least, the findings can be used to make decisions concerning dangerous. The COVID-19 virus can be prevented from spreading in the public by 67% via network protocols, according to experimental data.

By fusing IoT and ML [16], an innovative medical IoT concept was established to combat the global spread of COVID-19. Monitors for patients with COVID-19 were a goal of the study. A physical barrier between healthcare workers and patients was also pushed for. The technology may be able to send a patient's biological data to the correct allowing the healthcare specialists to speak with each other. In order to use this system, patients must wear biosensors and cameras, as well as touchscreens for communicating with doctors or nurses. Machine learning and computer vision algorithms are used to assess the data that has been collected. Sensors, cameras, and touchscreens may all be controlled and organised using Arduino and Raspberry Pi.

2.1 Challenges in Face Recognition

It is considered a difficult problem because the majority of searches are made among faces attending the same or different classes. In addition, only a small number of face shots are available to train the system, and the results are poor when training and testing images are taken in different circumstances. As a result of classifiers' sensitivity to factors such as light and angle of the classifiers' faces, the researchers have had to make compromises. Accordingly, recent research has been categorised.

3 Proposed technique

Individuals who have come into touch with an infected person should be isolated in a small area or at home to prevent the virus from spreading. Facial recognition software can help enforce this rule by analysing photos or videos taken by cameras and identifying these individuals. The authorities can be contacted if these people are spotted in public, and appropriate action can be taken. A Semi-supervised Modified Self-organizing Feature Map was employed by the researchers. In this proposed paradigm, it is possible to recognise and categorise human faces. The covid -19 positive incidences captured are stored in the cloud using an IoT technique. There has to be a dataset with full-face photos of the solitary people in it. Prior to examining public surveillance camera images, the face recognition algorithm learns from this dataset. Figure 2 depicts the proposed model diagram, which is shown here.

Figure 2: Proposed criterias

3.1 Dataset

The system installation used a camera, similar to other surveillance cameras (30 fps). This camera has been configured to record. A sample movie of 1263 seconds (4000 frames) has been examined for its detection accuracy and storage efficiency. Frame-by-frame, this video has been scrutinised by hand. For a total of 5000 motion frames, it has 2300 face frames and 2700 body-integrated frames. We used these findings as a starting point for our investigation. Figure 3 displays the various video frame samples.

Figure 3: From video frame figures extracted

Table 1: Specification of personal data

S.No	Covid positive case format
1	Address
2	Place
3	Phone number
4	Address
5	Name
6	Sex
7	Age
8	Specific id for the person

3.2 Cloud storage

Using Wi-Fi in cloud storage may be a realistic solution because it is widely used in indoor areas. You'll need a right of entry point in your Wi-Fi network if you're sending the collected data to a cloud service. IEEE 802.11 specifications are actively being developed for Wi-Fi-enabled wireless strategies. In terms of Wi-Fi standards, the most recent one is Wi-Fi 6 (802.11), which allows for faster and more reliable connections.

3.4 IoT

COVID-19 research has been heavily influenced by the Internet of Things. We can easily keep tabs on individuals, notably patients in hospitals, their homes, or even on the streets, thanks to Internet of Things (IoT) gadgets[42-55]. There are many advantages to using the IoT to collect and retain patient data. Patient history files, wearable technology, medical imaging devices, doctors and nurses, and other healthcare professionals can all contribute to the collection of medical data. The Internet of Things (IoT) offers numerous advantages to consumers, businesses, and people in their daily lives. In domains including health, safety, and security, new concepts in the Internet of Things (IoT) are emerging. As a result, this research aims to integrate loT into security systems in order to detect movement. As an additional advantage, this approach eliminates the need for machine-to-machine communication and so reduces the overall system weight for the user. Machines aren't necessary at both ends in this situation in order to achieve the desired output. The low power consumption and low cost of this system make it an excellent choice for home use[56-59]. As a result of the work being done on this project, motion detection will be made more user-friendly and alerts will be sent out much more quickly.

3.5 Semi-supervised Adapted Self-organizing Feature Map

A modified self-organizing feature map neural network is used to detect masks by training the network in a semi-supervised context. This concept of competitive earning is used. Input and output are the two layers of this system. Either a one- or a two-dimensional output layer is possible. The output layer in this study is two-dimensional (see Figure 3.1). Each neuron in the output layer has a weighted connection to all neurons in the input layer. The topological map of the input patterns is gradually generated by the SOFM, which is learned iteratively. There are three sequential processes in the training of the SOFM: competition, co-operation, and weight updating epoch by epoch until convergence.

3.6 Weight Initialization

Small amounts of labelled patterns are used in the MSOFM network's semi-supervised learning. This information can be gathered in numerous ways. This strategy, like the previous one, uses labelled patterns from the ground-truth with equal percentages for both classes for experimentation purposes. The labelled and unlabeled neurons' weights are initialised differently after the labelled patterns have been collected. Weights for output neurons are initialised with the normalised feature values of the labelled pattern if the class label of the pixel is known; otherwise, weights are initialised at random between [0, 1].

3.7 Learning by a Small Number of Labeled Patterns

The MSOFM network is fed a series of input patterns Xmn in order to train it. MSOFM has a neuron for each pixel location in the difference image, as was discussed in the preceding section. Weight vector of (m,n)th representative neuron of output layer for corresponding input patterns at the end of epth epoch is (w,w,w,w,w) W (m,n). d(m, n) is the dot product between Xmn and W ep mn.

$$d(m,n) \ = \ --\rightarrow Xmn \ \cdot \ ---\rightarrow W \ epmn \ = \ y\sum z = 1xmn,z \ \cdot \ wepmn,z \ . \qquad (1)$$

Using only the identified patterns, the network's connection weights are first modified during the training phase.

3.8 Computation of Unlabeled Patterns

Fuzzy set theory is used to allocate soft class labels to previously unlabeled patterns after they have been presented to the network. Each unlabeled pattern's membership values can be calculated for both classes. d(m, n) is computed using Equation 3.2, and the (m, n)th unlabeled pattern is more likely to be from the changed class if d(m, n) is more than than the unaffected class. The membership value of the (m, n)th unlabeled pattern is (m, n) = [[1(m, n), 2(m, n)] ; here, m and n are the two classes in which the pattern (m, n) is a member.

The pooling procedure ensures translation invariance. The picture size is reduced by half to 12 12 due to the kernel size of 2 2. Self-organizing There are many different approaches to construct a Feature Map structure. Subsampling layers, for example, have a variable sum and feature mappings.

A face picture taken from a distance is used as training data for the face recognition scheme is suggested. Expansion of the face image is used as a training approach to get the face image by increasing the distance between a camera and the user from 1 m to the point where they can recognise their own face[11-22]. The process of adjusting the histogram of an image so that it appears uniformly in all of the image's grayscale regions is known as histogram equalisation. With this adjustment, the histogram's intensities will be more evenly distributed. As a result, areas with low local contrast might be brought into sharper focus. Using histogram equalisation, the maximum frequency norms are efficiently spread out. It's necessary to indicate the function that will be used to convert the image's pixel value[23-41]. A technique for capturing a person's face at a distance using a camera while they move around in different postures. For facial identification, we used a semi-supervised Modified Self-organizing Feature Map, whereas Euclidean distance was used to measure similarity. It is possible to include the image Euclidean distance into existing image recognition processes that use Euclidean distance to determine the spatial relationship among the pixels in various images. Comparing the extracted face images by distance, the extracted face images have different sizes. If you use real distance to build a facial image. However, it has the disadvantage of necessitating more user engagement than a single distance face picture approach does.

4 Result and discussion

It is possible to verify a person's identify based on their facial features by detecting their faces in public images and verifying their identity. OpenCV was used in a Python context for this project. By using this methodology, the general public's exposure to covid 19 and the number of people dying from it would be reduced. We employ a Semi-supervised Modified Self-organizing Feature Map and a Euclidean distance approach for the face detector instead of customising the features. As a real-time system was the primary goal of this trial, the adaptive scheme's. despite its better accuracy. Because of this need for real-time results, a feature extraction technique was employed during the verification process.

Table 2: Struggle Value Task Policy

Blur		**Illumination**	**Expression**	**Pose**	**Occlusion**	
High Blur	**Normal Blur**	**High Expression**	**High Illumination**	**Heavy Occlusion**	**Partial Occlusion**	**Different Pose**
1	0.5	1	1	1	0.5	1

4.1 Evaluation Metrics

Various parametric metrics, such as specificity (SP), sensitivity (SE), Precision (P) and Accuracy (A), are used to evaluate and analyse the performance of the proposed method (AC). The following metrics can be expressed as a mathematical formula:

$$P = \frac{tp}{tp+fP} \quad (1)$$

$$SP = \frac{tn}{tn+fp} \quad (2)$$

$$\mathrm{AC} = \frac{tp+tn}{tp+fp+tn+fn} \quad (3)$$

$$SE = \frac{tp}{tp+fn} \quad (4)$$

Where,

$TP = True\ positive$

$TN = True\ Negative$

$FP = False\ Positive$

$FN = False\ Negative$

Table 3: presentation analysis of projected model with diverse condition

Different frames	Sensitivity	Precision	Specificity	Recall
Person (with mask)	61.20	61.55	62.35	68.51
Person (without mask)	71.56	76.99	70.15	72.56
Evening time	70.56	75.49	71.24	76.11
Night time	51.64	54.87	53.69	56.58
Evening time	70.56	75.49	71.24	76.11
Day time	81.54	83.56	79.56	75.87
Average	67.30	70.492	67.39	69.92

Table 3 and figure 5 show the suggested model's performance as measured by various criteria. Table 3 shows the conditions under which the performance is evaluated. Day timeframes fare better in this situation than other timeframes. Sensitivity is 67%; Specificity is 67%; Precision is 70%; and Recall is 69%; these are the averages for these four metrics.

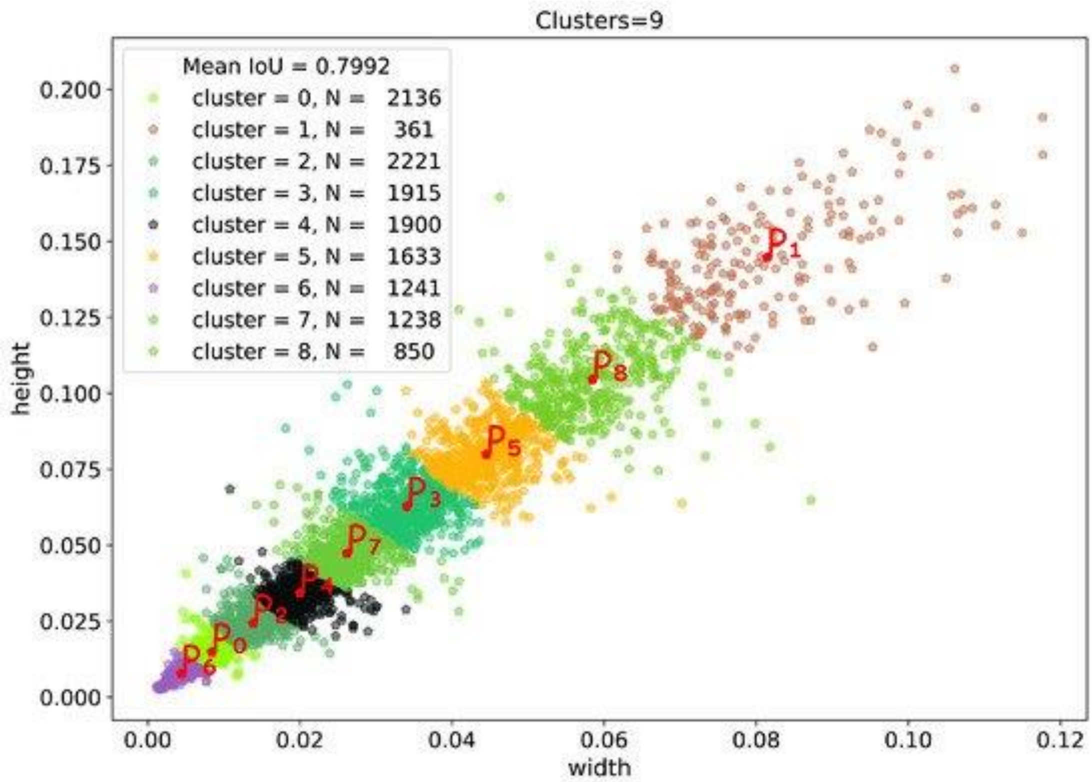

Figure 4: Results

5 Conclusion

With regard to face photographs in terms of appearance and location, our method represents the first to combine topic independence with robustness. Covid 19 and non-covid people's faces will be recognised by cameras that are connected to a cloud server. Semi-supervised Modified Self-organizing Feature Map is used to classify covid positive and normal cases in this recognition method. More than 2,000 test images from the gallery's 47 categories were analysed in this investigation, which included a wide range of lighting and posture settings. Accuracy in real-world testing was exceptionally high, and we also achieved detection rates close to 15 frames per second. This research was primarily focused on developing a real-time scheme, and while the adaptive arrangement achieved better accuracy, it was still unable to meet the real-time restriction. In addition, we want to use a high-resolution camera to record video and a more advanced recognition model to increase the model's performance.

Reference

[1]. Lynch RM, Goring R. Practical steps to improve air flow in long-term care resident rooms to reduce COVID-19 infection risk. Journal of the American Medical Directors Association. 2020 Jul 1;21(7):893-4.

[2]. Gkiotsalitis K, Cats O. Optimal frequency setting of metro services in the age of COVID-19 distancing measures. Transportmetrica A: Transport Science. 2021 Mar 9:1-21.

[3]. Stein RA. COVID-19 and rationally layered social distancing. International journal of clinical practice. 2020 Jul 14.

[4]. Kulkarni T, Sharma P, Pande P, Agrawal R, Rane S, Mahajan A. COVID-19: A review of protective measures. Cancer Research, Statistics, and Treatment. 2020 Jul 1;3(2):244.

[5]. Jones DL, Baluja MQ, Graham DW, Corbishley A, McDonald JE, Malham SK, Hillary LS, Connor TR, Gaze WH, Moura IB, Wilcox MH. Shedding of SARS-CoV-2 in feces and urine and its potential role in person-to-person transmission and the environment-based spread of COVID-19. Science of the Total Environment. 2020 Dec 20;749:141364.

[6]. Rathore, M. S., Poongodi, M., Saurabh, P., Lilhore, U. K., Bourouis, S., Alhakami, W., ... & Hamdi, M. (2022). A novel trust-based security and privacy model for Internet of Vehicles using encryption and steganography. *Computers and Electrical Engineering*, *102*, 108205.

[7]. Poongodi, M., Bourouis, S., Ahmed, A. N., Vijayaragavan, M., Venkatesan, K. G. S., Alhakami, W., & Hamdi, M. (2022). A Novel Secured Multi-Access Edge Computing based VANET with Neuro fuzzy systems based Blockchain Framework. *Computer Communications*.

[8]. Ramesh, T. R., Lilhore, U. K., Poongodi, M., Simaiya, S., Kaur, A., & Hamdi, M. (2022). PREDICTIVE ANALYSIS OF HEART DISEASES WITH MACHINE LEARNING APPROACHES. *Malaysian Journal of Computer Science*, 132-148.

[9]. Poongodi, M., Malviya, M., Hamdi, M., Vijayakumar, V., Mohammed, M. A., Rauf, H. T., & Al-Dhlan, K. A. (2022). 5G based Blockchain network for authentic and ethical keyword search engine. *IET Commun.*, *16*(5), 442-448.

[10]. Poongodi, M., Malviya, M., Kumar, C., Hamdi, M., Vijayakumar, V., Nebhen, J., & Alyamani, H. (2022). New York City taxi trip duration prediction using MLP and XGBoost. *International Journal of System Assurance Engineering and Management*, *13*(1), 16-27.

[11]. Poongodi, M., Hamdi, M., & Wang, H. (2022). Image and audio caps: automated captioning of background sounds and images using deep learning. *Multimedia Systems*, 1-9.

[12]. Poongodi, M., Hamdi, M., Gao, J., & Rauf, H. T. (2021, December). A Novel Security Mechanism of 6G for IMD using Authentication and Key Agreement Scheme. In *2021 IEEE Globecom Workshops (GC Wkshps)* (pp. 1-6). IEEE.

[13]. Ramesh, T. R., Vijayaragavan, M., Poongodi, M., Hamdi, M., Wang, H., & Bourouis, S. (2022). Peer-to-peer trust management in intelligent transportation system: An Aumann's agreement theorem based approach. *ICT Express*.

[14]. Hamdi, M., Bourouis, S., Rastislav, K., & Mohmed, F. (2022). Evaluation of Neuro

Image for the Diagnosis of Alzhimer's Disease Using Deep Learning Neural Network. *Frontiers in Public Health*, 35.

[15]. Poongodi, M., Hamdi, M., Malviya, M., Sharma, A., Dhiman, G., & Vimal, S. (2022). Diagnosis and combating COVID-19 using wearable Oura smart ring with deep learning methods. *Personal and ubiquitous computing*, *26*(1), 25-35.

[16]. Sahoo, S. K., Mudligiriyappa, N., Algethami, A. A., Manoharan, P., Hamdi, M., & Raahemifar, K. (2022). Intelligent Trust-Based Utility and Reusability Model: Enhanced Security Using Unmanned Aerial Vehicles on Sensor Nodes. *Applied Sciences*, *12*(3), 1317.

[17]. Muniyappan, A., Sundarappan, B., Manoharan, P., Hamdi, M., Raahemifar, K., Bourouis, S., & Varadarajan, V. (2022). Stability and numerical solutions of second wave mathematical modeling on covid-19 and omicron outbreak strategy of pandemic: Analytical and error analysis of approximate series solutions by using hpm. *Mathematics*, *10*(3), 343.

[18]. Rawal, B. S., Manogaran, G., & Poongodi, M. (2022). Implementing and Leveraging Blockchain Programming.

[19]. Bourouis, S., Band, S. S., Mosavi, A., Agrawal, S., & Hamdi, M. (2022). Meta-Heuristic Algorithm-Tuned Neural Network for Breast Cancer Diagnosis Using Ultrasound Images. *Frontiers in Oncology*, *12*, 834028.

[20]. Lilhore, U. K., Poongodi, M., Kaur, A., Simaiya, S., Algarni, A. D., Elmannai, H., ... & Hamdi, M. (2022). Hybrid Model for Detection of Cervical Cancer Using Causal Analysis and Machine Learning Techniques. *Computational and Mathematical Methods in Medicine*, *2022*.

[21]. Dhiman, P., Kukreja, V., Manoharan, P., Kaur, A., Kamruzzaman, M. M., Dhaou, I. B., & Iwendi, C. (2022). A Novel Deep Learning Model for Detection of Severity Level of the Disease in Citrus Fruits. *Electronics*, *11*(3), 495.

[22]. Dhanaraj, R. K., Ramakrishnan, V., Poongodi, M., Krishnasamy, L., Hamdi, M., Kotecha, K., & Vijayakumar, V. (2021). Random Forest Bagging and X-Means Clustered Antipattern Detection from SQL Query Log for Accessing Secure Mobile Data. *Wireless Communications and Mobile Computing*, *2021*.

[23]. Maurya, S., Joseph, S., Asokan, A., Algethami, A. A., Hamdi, M., & Rauf, H. T. (2021). Federated transfer learning for authentication and privacy preservation using novel supportive twin delayed DDPG (S-TD3) algorithm for IIoT. *Sensors*, *21*(23), 7793.

[24]. Poongodi, M., Nguyen, T. N., Hamdi, M., & Cengiz, K. (2021). Global cryptocurrency trend prediction using social media. *Information Processing & Management*, *58*(6), 102708.

[25]. Poongodi, M., Sharma, A., Hamdi, M., Maode, M., & Chilamkurti, N. (2021). Smart healthcare in smart cities: wireless patient monitoring system using IoT. *The Journal of Supercomputing*, *77*(11), 12230-12255.

[26]. Rawal, B. S., Manogaran, G., & Hamdi, M. (2021). Multi-Tier Stack of Block Chain with Proxy Re-Encryption Method Scheme on the Internet of Things Platform. *ACM Transactions on Internet Technology (TOIT)*, *22*(2), 1-20.

[27]. Poongodi, M., Malviya, M., Hamdi, M., Rauf, H. T., Kadry, S., & Thinnukool, O. (2021). The recent technologies to curb the second-wave of COVID-19 pandemic. *Ieee Access*, *9*, 97906-97928.

[28]. Rawal, B. S., Manogaran, G., Singh, R., Poongodi, M., & Hamdi, M. (2021, June). Network augmentation by dynamically splitting the switching function in SDN. In *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1-6). IEEE.

[29]. Poongodi, M., Hamdi, M., Varadarajan, V., Rawal, B. S., & Maode, M. (2020, July). Building an authentic and ethical keyword search by applying decentralised (Blockchain) verification. In *IEEE INFOCOM 2020-IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)* (pp. 746-753). IEEE.

[30]. Poongodi, M., Vijayakumar, V., Al-Turjman, F., Hamdi, M., & Ma, M. (2019). Intrusion prevention system for DDoS attack on VANET with reCAPTCHA

controller using information based metrics. *IEEE Access*, *7*, 158481-158491.

[31]. Poongodi, M., Hamdi, M., Sharma, A., Ma, M., & Singh, P. K. (2019). DDoS detection mechanism using trust-based evaluation system in VANET. *IEEE Access*, *7*, 183532-183544.

[32]. Delen D, Eryarsoy E, Davazdahemami B. No place like home: cross-national data analysis of the efficacy of social distancing during the COVID-19 pandemic. JMIR public health and surveillance. 2020;6(2):e19862.

[33]. Moorthy R, Upadhya V, Holla VV, Shetty SS, Tantry V. CNN based smart surveillance system: A smart iot application post Covid-19 era. In2020 Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC) 2020 Oct 7 (pp. 72-77). IEEE.

[34]. Elharrouss O, Almaadeed N, Al-Maadeed S. A review of video surveillance systems. Journal of Visual Communication and Image Representation. 2021 Apr 16:103116.

[35]. Sun X, Wu P, Hoi SC. Face detection using deep learning: An improved faster RCNN approach. Neurocomputing. 2018 Jul 19;299:42-50.

[36]. Rahmatizadeh S, Valizadeh-Haghi S, Dabbagh A. The role of artificial intelligence in management of critical COVID-19 patients. Journal of Cellular and Molecular Anesthesia. 2020 Apr 9;5(1):16-22.

[37]. Y. Tian, Y. Zhang, Y. Fu, and C. Xu, "Tdan: Temporally-deformable alignment network for video super-resolution," in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), June 2020.

[38]. T. Xue, B. Chen, J. Wu, D. Wei, and W. T. Freeman, "Video enhance- ment with task-oriented flow," International Journal of Computer Vision,vol. 127, no. 8, pp. 1106–1125, 2019.

[39]. S. Su, M. Delbracio, J. Wang, G. Sapiro, W. Heidrich, and O. Wang,"Deep video deblurring for hand-held cameras," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2017, pp. 1279–1288

[40]. M. Najibi, P. Samangouei, R. Chellappa, and L. S. Davis, "Ssh: Single stage headless face detector," in Proceedings of the IEEE International Conference on Computer Vision (ICCV), 2017.

[41]. M. Hassan and S. T. Hasson, "A controllability algorithm to minimize the spreading chance of COVID-19 in individual networks," in Proc. 4th Int. Conf. I-SMAC, Palladam, India, 2020, pp. 1–5.

[42]. M. M. S. Choyon, M. Rahman, M. M. Kabir, and M. F. Mridha, "IoT-based health monitoring & automated predictive system to confront COVID-19," in Proc. IEEE 17th Int. Conf. Smart Communities: Improving Quality of Life Using ICT, IoT and A.I. (HONET), Charlotte, NC, USA, 2020, pp. 189–193.

[43]. Asghar, M. Z., Albogamy, F. R., Al-Rakhami, M. S., Asghar, J., Rahmat, M. K., Alam, M. M., ... & Nasir, H. M. (2022). Facial Mask Detection Using Depthwise Separable Convolutional Neural Network Model During COVID-19 Pandemic. *Frontiers in Public Health*, *10*.

[44]. Crespo, F.; Crespo, A.; Sierra-Martínez, L.M.; Peluffo-Ordóñez, D.H.; Morocho-Cayamcela, M.E. A Computer Vision Model to Identify the Incorrect Use of Face Masks for COVID-19 Awareness. *Appl. Sci.* **2022**, *12*, 6924. https://doi.org/10.3390/app12146924

[45]. M. M. Kamruzzaman, ""New Opportunities, Challenges, and Applications of Edge-AI for Connected Healthcare in Smart Cities,"" 2021 IEEE Globecom Workshops (GC Wkshps), 2021, pp. 1-6, doi: 10.1109/GCWkshps52748.2021.9682055."

[46]. Md Selim Hossain, MM Kamruzzaman, Shuvo Sen, Mir Mohammad Azad, Mohammad Sarwar Hossain Mollah, Hexahedron core with sensor based photonic crystal fiber: An approach of design and performance analysis," Sensing and Bio-Sensing Research, 32, 100426

[47]. Mingju Chen, Xiaofeng Han, Hua Zhang, Guojun Lin, M.M. Kamruzzaman, Quality-guided key frames selection from video stream based on object detection, Journal of Visual Communication and Image Representation, Volume 65, 2019, 102678, ISSN 1047-3203

[48]. M. M. Kamruzzaman: Performance of Decode and Forward MIMO Relaying using STBC for Wireless Uplink. JNW 9(12): 3200-3206 (2014)

[49]. M. M. Kamruzzaman, "Performance of Turbo Coded Vertical Bell Laboratories Layered Space Time Multiple Input Multiple

Output system," Computer and Information Technology (ICCIT), 2013 16th International Conference on, Khulna, 2014, pp. 455-459.

[50]. Yan Zhang, M. M. Kamruzzaman, and Lu Feng "Complex System of Vertical Baduanjin Lifting Motion Sensing Recognition under the Background of Big Data," Complexity, vol. 2021, Article ID 6690606, 10 pages, 2021. https://doi.org/10.1155/2021/6690606

[51]. Md Hossain , MM Kamruzzaman , Shuvo Sen, Mir Mohammad Azad, Mohammad Sarwar Hossain Mollah , Hexahedron Core with Sensor Based Photonic Crystal Fiber, 2021

[52]. Md Nazirul Islam Sarker, Md Lamiur Raihan, Yang Peng, Tahmina Chumky, MM Kamruzzaman, Roger C Shouse, Huh Chang Deog, "COVID-19: Access to Information, Health Service, Daily Life Facility and Risk Perception of Foreigners during Coronavirus pandemic in South Korea," Archives of Medical Science, 2021, https://doi.org/10.5114/aoms/141164

[53]. Y. Shi, S. Wang, S. Zhou and M. M. Kamruzzaman. (2020). Study on Modeling Method of Forest Tree Image Recognition Based on CCD and Theodolite. IEEE Access, vol. 8, pp. 159067-159076, 2020, doi: 10.1109/ACCESS.2020.3018180

[54]. Guobin Chen, Zhiyong Jiang, M.M. Kamruzzaman. (2020). Radar remote sensing image retrieval algorithm based on improved Sobel operator, Journal of Visual Communication and Image Representation, Volume 71, 2020, 102720, ISSN 1047-3203 https://doi.org/10.1016/j.jvcir.2019.102720.

[55]. Yuanjin Xu, Ming Wei, M.M. Kamruzzaman, Inter/intra-category discriminative features for aerial image classification: A quality-aware selection model,Future Generation Computer Systems,Volume 119,2021,Pages 77-83,ISSN 0167-739X,https://doi.org/10.1016/j.future.2020.11.015.

[56]. Xing Li, Junpei Zhong, M.M. Kamruzzaman, "Complicated robot activity recognition by quality-aware deep reinforcement learning", Future Generation Computer Systems,Volume 117, 2021, Pages 480-485.

[57]. Bin Yuan, M. M. Kamruzzaman, Shaonan Shan, "Application of Motion Sensor Based on Neural Network in Basketball Technology and Physical Fitness Evaluation System", Wireless Communications and Mobile Computing, vol. 2021, Article ID 5562954, 11 pages, 2021. https://doi.org/10.1155/2021/5562954

[58]. Chi, Z., Jiang, Z., Kamruzzaman, M.M. et al. Adaptive momentum-based optimization to train deep neural network for simulating the static stability of the composite structure. Engineering with Computers (2021). https://doi.org/10.1007/s00366-021-01335-5