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Covid-19 detection using CT scan based on gray level Co-Occurrence matrix

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ABSTRACT

The Coronavirus pandemic is one of the biggest problems the world has faced in the 21st century and this virus is a virus that infects the lung and causes breathing problems. In this research the program is designed for the purpose of reading images of the type CT scan, this study used 654 case these cases split in to two classes (infect , not infect), there are two phases in this study, training phase and testing phase. After training the training data store in database, the second phase is testing at first is pre-processing step which increase contrast, then remove lung by labelling the most contrast connected pixels and subtract labelling pixels from original image, the next step is noise removal by applying three filters (mean, median, Gaussian), after that applying gray level co-occurrence matrix (GLCM) in four directions (0°,45°,90° and 135°), then extract features from GLCM, in this study 10 features was extracted from each GLCM matrix, then compare between testing features and training database to specify the case is infect or not, in this study get accuracy 94% for detect the location of infection and detect the lung is infect or not.

1. Introduction

In Dec. 2019, a disease outbreak has been reported in Wuhan, China, with a new coronavirus that has been referred to as the Severe Acute Respiratory Syndrome Coronavirus II (SARS-CoV2) [1]. The World Health Organization (WHO) after that named this disease as the Coronavirus Disease 2019 (COVID-19). On Mar. 11, 2020, WHO have announced the COVID-19 as pandemic [2], with 10,021,401 confirmed cases and 499,913 reported deaths all over the world, by Jun. 29, 2020 [3]. The computer vision systems' development has supported medical applications like the increase in image quality, organ texture classification and organ segmentation. The analyses of the tumor properties and time series (2), detection and segmentation (3) of tumor modules are a few of machine learning applications in the area of the bio-medical image processing [4].

Compared to the chest X-ray, the CT has more clear information and it offers better judgement accuracy hence, this research work considered only the CT for the examination. Rodriguez-Morales et al.27 present a review of the detection and prediction of COVID-19 pneumonia infection [5]. The current procedures used in the identification of the virus require an experienced radiologist, hence automatic detection would be essential to reduce the assessment time for radiologists. The work in 28 reviews the recent image processing techniques.

In this research, 654 CT images have been utilized for the classification of COVID-19. Prior to the process of the classification, data-set samples have been classified as coronavirus / non-coronavirus (i.e. infected / non-infected) [6]. Feature extraction approaches with the use of the Euclidian distance and gray level co-occurrence matrix have been utilized throughout the COVID-19 image classification. The results have shown that the suggested approach may be utilized for the diagnosis of COVID-19 as an assisting system [7]. For further studies, refer to [8,9,18–27,10–17]

2. Dataset

Dataset used in this study contains 654 CT scan images and is classified as the follows:

a. First part contains healthy CT scan image of any infection. This part contains 410 CT scan images.

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b. The second part contains the CT scan images with non-infection. This part contains 244 images

The dataset is split into two parts. The first part consists of 70% images used for training system. The second part consists of 30% images used for testing the proposed system. Fig. 1 illustrate CT scan images of dataset.

3. Proposed system

The presented section describes the suggested approach for efficient segmentation and detection of infection from CT scan images which includes five steps (pre-processing, image enhancement, segmentation, features extraction and classification).

3.1. Proposed system architecture

This step represents the proposed system work as flowchart show in Fig. 2 that illustrates the training steps. Fig. 3 illustrates the testing steps. The steps of the work are identified in details. The training steps can be split into two parts, the first part is the pre-processing of images, while the second part is applying GLCM and feature extraction. Figure 2, illustrates flowchart of training part, Figure 3 illustrates testing part.

3.2. Proposed system steps

A few steps of pre-processing will be done to the raw input CT scan image; thus, images will be transformed to adequate form for more processing. In such step, the raw image will include a lot of undesired information (noise). Initially a tracking algorithm is used.

Step 1: Loading CT scan image

Step2: Increase contrast of loading image.

Step3: Every one of the elements corresponding to a gray value between (0 and 255).

Step 4: Using a 2D matrix for storing the image.

Step 5: Lung elimination by read pixels of image and search about first white pixel then label first row of lung, then begin with label every pixel connect with labelling pixels.

Step 6: Subtract extracted lung from gray image.

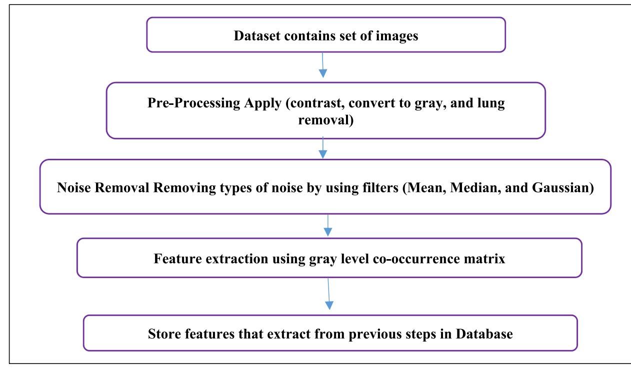

Fig 2. Block diagram of training dataset.

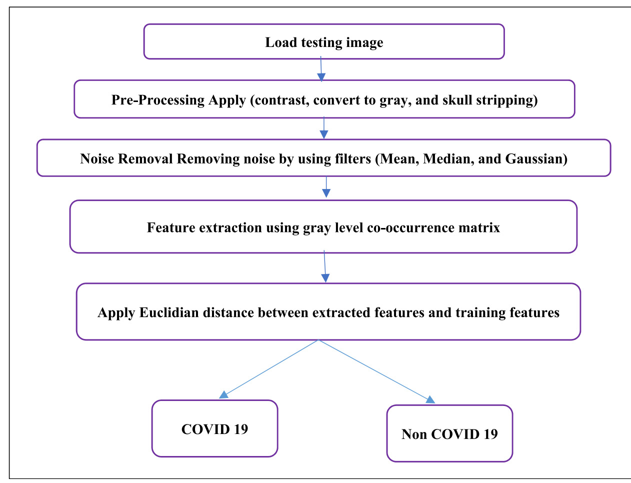

Fig. 3. Block diagram of testing steps.

3.3. Noise removal

Image Enhancement might be defined as a process used to enhance the appearance of images with regard to better visibility and contrast. At this part the images which are 457 image input

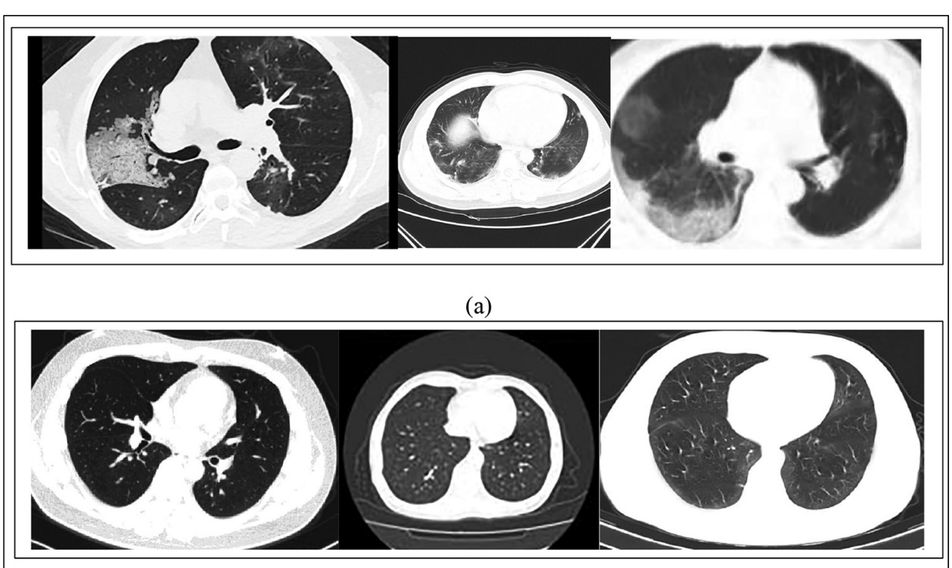

Fig 1. (a) illustrate samples of infection images of CT scan in dataset (b) illustrate samples of non-infection images of CT scan in dataset.

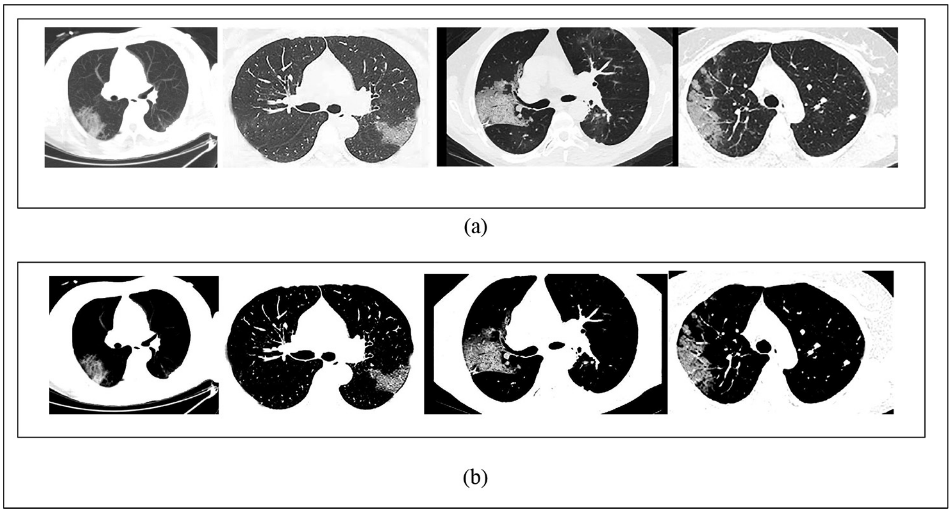

Fig. 4. (a) illustrated sample from dataset. (b) Illustrated applying contrast on image.

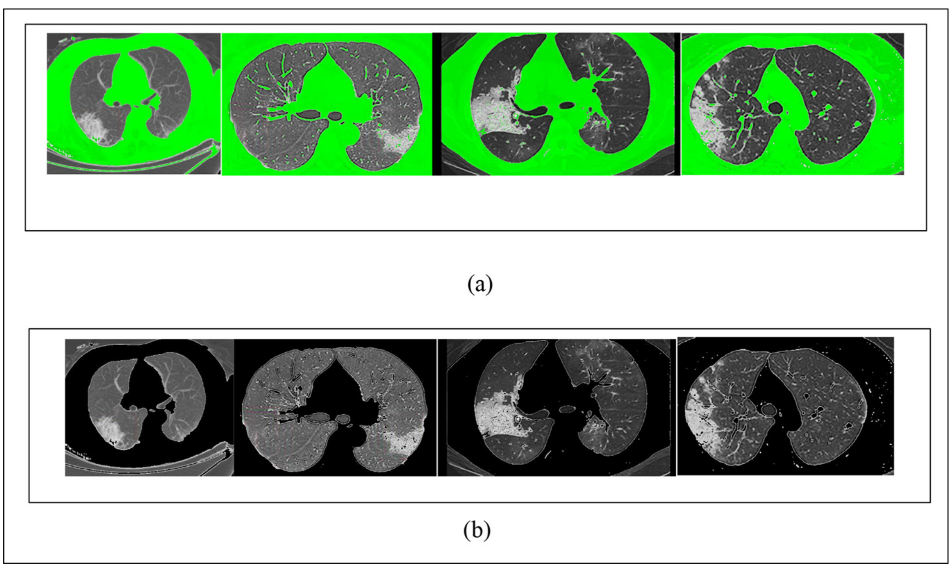

Fig. 5. (a) illustrated lung labeling step, (b) illustrated images after lung removal.

Table 1
illustrates GLCM for first image test.

14,825	127	112	27	17	67	178	58
204	143	132	32	8	1	0	0
152	204	647	269	29	5	2	0
46	37	362	928	352	28	9	0
19	8	48	442	1406	450	122	0
25	1	8	56	547	1391	765	10
86	2	3	14	135	839	1465	42
43	2	0	0	1	22	45	12

to preprocessing in order to optimize the CT scan images. This images are classify into types of diseases. The first step in this part is apply three filters which are (mean, Gaussian, and median filters), these filters will removing the noise and enhance the image. In mean filter, a mask size will be determining the loss of details and degree smoothing. Also, the noise that is randomly vary below and over normal brightness value might be decreased via averaging neighborhood of values. Median filter is one of the majorly recognized statistics filters, it is replacing the pixel value by the median regarding grey levels in pixel's neighborhood, while the pixel original value will be involved in computations of median, such filters are widely utilized due to the fact that in specific random noise types, they will be providing efficient capabilities of noise-reduction, with significantly less blurring in comparison to the small size linear smoothing filters. Also, such filters are especially important with the existence of unipolar and bipolar impulse

Table 2
illustrates GLCM for Second image test.

13,323	273	118	34	16	25	58	36
210	193	133	72	15	7	0	0
92	109	253	225	45	6	6	2
21	42	194	798	309	45	7	2
15	8	31	276	809	338	31	2
34	3	6	21	302	785	260	4
90	1	1	4	33	216	504	43
36	0	1	0	2	9	38	20

Table 3
illustrates GLCM for third image test.

18,882	226	55	53	37	67	223	134
219	617	253	38	11	11	9	10
83	246	751	271	68	28	19	2
52	48	284	885	404	75	39	8
38	12	90	394	1034	377	114	15
58	14	37	96	356	815	399	38
176	16	18	60	147	402	1110	188
87	2	2	17	27	44	214	113

Table 4
illustrates GLCM for fourth image test.

14,779	100	42	16	10	6	31	41
111	113	67	25	3	1	0	0
43	89	190	93	29	2	0	0
10	13	124	384	139	19	4	0
7	2	19	153	393	129	14	3
8	1	2	18	128	401	112	2
35	0	1	1	18	111	417	40
38	0	0	0	0	3	45	41

Table 5
illustrates features extracted from testing images.

	Contrast	Correlation	Energy	Homogeneity	Mean	Standard Deviation	Entropy	RMS	Kurtosis	Skewness
Image 1	0.1187	0.9798	0.2332	0.9418	1.9064	0.5737	0.6839	1.5969	1.7449	−0.4768
Image 2	0.334	0.959	0.126	0.8694	1.5703	0.6728	0.7127	1.5969	1.4839	0.1819
Image 3	0.45	0.9633	0.1259	0.842	1.2276	0.8179	0.7522	1.586	1.551	0.3254
Image 4	0.2052	0.9574	0.1718	0.9053	1.4422	0.5016	0.7163	1.5969	2.2041	0.6301

noise. Gaussian filter: As soon as calculating an adequate kernel, Gaussian smoothing will be achieved with the use of standard convolution approaches. Actually, the convolution might be fairly quickly achieved as the equation for 2-D isotropic Gaussian was separated into × as well as y components.

3.4. Apply GLCM and feature extraction

One of the statistical approaches for examining the textures considering the pixel spatial relations is the GLCM, such approach is characterizing the image texture via estimating how frequently pixel pairs with certain values as well as in certain spatial relationships exists in the image. This achieves the extraction related to the statistical measures from such matrix. GLCM is created via gray-comatrix function through estimating how regularly a pixel with the intensity (grey-level) value (for example) row happens in certain spatial relationship to the pixel with a value by column and row. The relation is specified as the picture elements in terms of features present and the pixel to adjacent. At this step system will determine shape of extracted region in order to allow to recognize lung contain COVID 19.

4. Experimental results

The first steps is pre-processing which is applying contrast step to increase the light of testing image

Then convert image to gray scale Figure 4 illustrates dataset, and the result of contrast and convert to gray scale.

The second step is lung removal by labelling high contrast and connected region with lung, Figure 5 illustrates lung labelling, and then subtract the labelling region from original image to remove lung.

Applying three filters to remove noises from the images and enhancement them.

A. Applying Mean Filter

Mean filter is the first filter was apply in pre-processing, this filter will remove some types of noises like grain noise from the images, and by using the mask of mean filter will compute average of neighbors pixels and remove noise.

B. Applying Median Filter

Median filter is most common filter to remove and clean the images from noises, median filter can greatly reducing the time of the cleaning.

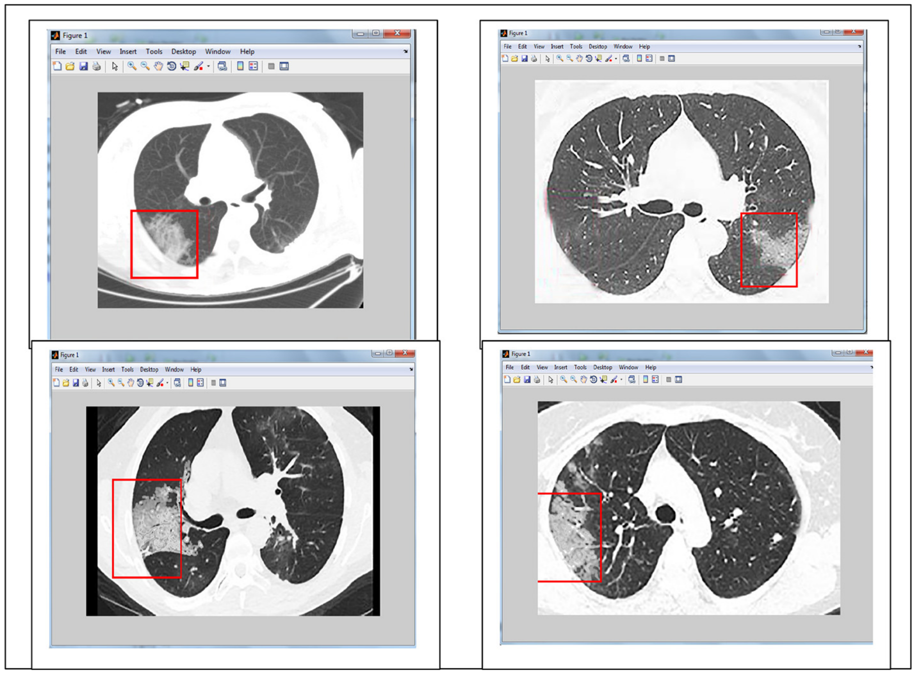

Fig. 6. illustrated final result of some testing samples and specify location of COVID 19 in CT scan images.

C. Applying Gaussian Filter:

Gaussian filter remove the random variation brightness information from images, by applying Gaussian filter, the types of noises remove are: (Salt and pepper noise, Gaussian noise, and Speckle noise.

Then Applying GLCM, the GLCM read texture of tumor in four angles (0°,45°,90° and 135°) to generate four matrices for each image. Table 1 illustrates GLCM for first testing image, Table 2 illustrates GLCM for second testing image. Table 3 illustrates GLCM for third testing image. Table 4 illustrates GLCM for fourth testing image.

From this matrixes extract features for each testing image as Table 5.

Now system apply Euclidian distance to compare between testing image and training database to specify the testing image with COVID 19 or not and location of it as in Figure 6.

5. Conclusion

a. The algorithms and approaches that have been utilized in this system, particularly in the feature extraction stage, are simple and utilize less amount of the memory. It is easy to understand and involves no complicated mathematical formulas.

b. Ability of the system can be increased with the use additional characteristics in the input dataset.

c. Time consuming for execution of all step in proposed system is less than two second.

d. The accuracy of the proposed system reached 94% on a used dataset.

f. Determine whether there is a COVID 19 or not as well as in order to facilitate the work of the doctor in the diagnosis and alert if nothing is noticed in the picture.

g. The filters were used to filter CT scan image, which are mostly snouted due to the movement of the patient or the device that was picked up poorly.

CRediT authorship contribution statement

Aseel Qassim Abdul Ameer: Conceptualization, Methodology, Software, Data curation, Visualization, Writing - original draft. **Raghad Falih Mohammed:** Investigation, Supervision, Software, Validation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] C. Huang et al., Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China, Lancet 395 (10223) (2020) 497–506.

[2] P. Huang et al., Added value of computer-aided CT image features for early lung cancer diagnosis with small pulmonary nodules: a matched case-control study, Radiology 286 (1) (2018) 286–295.

[3] A. Esteva et al., Dermatologist-level classification of skin cancer with deep neural networks, Nature 542 (7639) (2017) 115–118.

[4] X. Xu et al., A deep learning system to screen novel coronavirus disease 2019 pneumonia, Engineering 6 (10) (2020) 1122–1129.

[5] S.A. Fadaee, M.A. Haeri, Classification using link prediction, Neurocomputing 359 (2019) 395–407.

[6] A.A. Ardakani, A.R. Kanafi, U.R. Acharya, N. Khadem, A. Mohammadi, Application of deep learning technique to manage COVID-19 in routine clinical practice using CT images: Results of 10 convolutional neural networks, Comput. Biol. Med. 121 (2020) 103795.

[7] M. Ilyas, H. Rehman, and A. Na\"\it-Ali, "Detection of covid-19 from chest x-ray images using artificial intelligence: An early review," arXiv Prepr. arXiv2004.05436, 2020.

[8] H.J. Mohammed, I.A. Al-Jubori, M.M. Kasim, Evaluating project management criteria using fuzzy analytic hierarchy Process, AIP Conf. Proc. 2138 (1) (2019), https://doi.org/10.1063/1.5121097.

[9] H.J. Mohammed, M.M. Kasim, E.A. Al-Dahneem, A.K. Hamadi, Evaluating different multimedia learning methodologies by using the MACBETH method, in Recent Trends in Applied and Associated Mathematical Sciences, Penerbit Univ Kebangsaan Malaysia, 2019, pp. 58–73.

[10] H.J. Mohammed, M.M. Kasim, I.N. Shaharanee, Multi-criteria evaluation of e-learning approaches, in Proceedings of the 6th International Conference on Computing and Informatics, 2017.

[11] H.J. Mohammed, M.M. Kasim, E.A. AL-Dahneem, A.K. Hamadi, An analytical survey on implementing best practices for introducing e-learning programs to students, J. Educ Soc. Sci. 5 (2) (2016) 191–196.
[12] H.J. Mohammed, E.A. AL-dahneem, A.K. Hamadi, A comparative analysis for adopting an innovative pedagogical approach of flipped teaching for active classroom learning, J. Glob. Bus. Soc. Entrep. 3 (5) (2016) 86–94.
[13] H.J. Mohammed, M.M. Kasim, I.N. Shaharanee, Selection of suitable e-learning approach using TOPSIS technique with best ranked criteria weights, AIP Conf. Proc 1905 (2017), https://doi.org/10.1063/1.5012207.
[14] H.J. Mohammed, M.M. Kasim, A.K. Hamadi, E.A. Al-Dahneem, Evaluating of collaborative and competitive learning using MCDM technique, Adv. Sci. Lett. 24 (6) (Jun. 2018) 4084–4088.
[15] H.A. Daham, H.J. Mohammed, An evolutionary algorithm approach for vehicle routing problems with backhauls, Mater. Today Proc. (2021), https://doi.org/10.1016/j.matpr.2020.12.1028.
[16] S. Hashemi, A. Marzuki, H.J. Mohammed, S. Kiumarsi, The effects of perceived conference quality on attendees' behavioural intentions, Anatolia 31 (3) (2020) 360–375, https://doi.org/10.1080/13032917.2020.1729215.
[17] H.J. Mohammed, M.M. Kasim, I.N. Shaharanee, Evaluation of e-learning approaches using AHP-TOPSIS technique, J. Telecommun. Electron. Comput. Eng. 10 (1–10) (2018) 7–10.
[18] J.S. Ahmed, H.J. Mohammed, I.Z. Chaloob, Application of a fuzzy multi-objective defuzzification method to solve a transportation problem, Mater. Today Proc. (2021), https://doi.org/10.1016/j.matpr.2020.12.1062.
[19] H.J. Mohammed, H.A. Daham, Analytic hierarchy process for evaluating flipped classroom learning, Comput. Mater. Contin. 66 (3) (2021) 2229–2239, https://doi.org/10.32604/cmc.2021.014445.
[20] H.J. Mohammed, The optimal project selection in portfolio management using fuzzy multi-criteria decision-making methodology, J. Sustain. Financ. Invest. (2021), https://doi.org/10.1080/20430795.2021.1886551.
[21] B. Al Hayani, H. Ilhan, Visual sensor intelligent module based image transmission in industrial manufacturing for monitoring and manipulation problems, J. Intell. Manuf. 4 (2020) 1–14.
[22] B. Alhayani, H. Ilhan, Hyper spectral image classification using dimensionality reduction techniques, Int. J. Innov. Res. Electr. Electron. Instrum. Control Eng. 5 (4) (2017) 71–74.
[23] B. Al-Hayani, H. Ilhan, Efficient cooperative image transmission in one-way multi-hop sensor network, Int. J. Electr. Eng. Educ. 57 (4) (2020) 321–339.
[24] B. Alhayani, A. Abdallah, Manufacturing intelligent corvus corone module for a secured two way image transmission under WSN, Eng. Comput. 37 (9) (2020) 1–17.
[25] B. Al Hayani, H. Ilhan, Image transmission over decode and forward based cooperative wireless multimedia sensor networks for Rayleigh fading channels in medical Internet of Things (MIoT) for remote health-care and health communication monitoring, J. Med. Imaging Heal. Informatics 10 (1) (2020) 160–168.
[26] B. Alhayani, H.J. Mohammed, I.Z. Chaloob, J.S. Ahmed, Effectiveness of artificial intelligence techniques against cyber security risks apply of IT industry, Mater. Today Proc. (2021), https://doi.org/10.1016/j.matpr.2021.02.531.
[27] B. Alhayani, S.T. Abbas, D.Z. Khutar, H.J. Mohammed, Best ways computation intelligent of face cyber attacks, Mater. Today Proc. (2021), https://doi.org/10.1016/j.matpr.2021.02.557.