Mathematical Statistician and Engineering Applications
ISSN: 2094-0343
2326-9865

# Automatic Detection of Malaria Using Convolutional Neural Network

Tabark Mohammed Alkhaldi, Asaad Noori Hashim

Faculty of Computer Science and Mathematics, University of Kufa, Iraq

asaad.alshareefi@uokufa.edu.iq

tabarkm.alkhalidy@student.uokufa.edu.iq

**Article Info**
**Page Number: 939 – 947**
**Publication Issue:**
**Vol. 71 No. 3s2 (2022)**

**Article History**
**Article Received:** 28 April 2022
**Revised:** 15 May 2022
**Accepted:** 20 June 2022
**Publication:** 21 July 2022

**Abstract:** It's an infectious parasitic disease spread by mosquitoes that's caused by a parasite called (Plasmodium). This parasite infects and destroys red blood cells in the human body. Fever, anemia, spleen enlargement, headache, chills, and exhaustion are among the most common symptoms. Blood smears from individuals are still planned under the microscope by competent professionals and technicians for red blood cells contaminated with parasites, which is the classic approach for diagnosing malaria. The wait for a diagnosis is long. Deep learning algorithms have been used to infected human blood signals as a result, however the practical performance has so far been insufficient. The architecture of the convolutional neural network (CNN) was used in this paper to diagnose malaria illness using deep learning. , which includes 43,828 pictures of infected and uninfected blood cells were used to train on various weighted layers to assess the presence or absence of malaria in red blood cells from microscopic images collected of blood smears of infected human persons. A total accuracy of 96.87 was attained when the CNN model was tested. The proposed deep learning approach for detecting malaria was found to be effective based on the experimental results on the clinical data set.

**Keywords:** malaria ,deep learning , machine learning ,CNN

## 1. Introduction :

Malaria is a contagious disease, and the World Health Organization has announced an outbreak of the disease in many countries. The cause of this disease is a virus known as Plasmodium, which lives in the mother mosquito's body and is injected into the blood of a healthy person as soon as a mosquito bites a person, and humans are often susceptible to infection with this disease according to World Health Organization reports, the number of Another interesting fact from these studies is that 272,000 people died of malaria[1][2], with children under the age of five being the most affected.. As a result, it is one of the leading causes of death for children around the world, particularly in African countries. Despite the fact that there are therapeutic medications to treat malaria, there is currently no viable vaccine, making it a very effective sector. [3] Malaria is a disease that can be passed from one person to another; therefore, it is vital to protect yourself. It is still a method to diagnose it early and hence prevent its spread. The importance of a correct and successful malaria diagnosis cannot be overstated. Only a skilled microscope can accomplish this. Hundreds of billions of microscopic images are examined by the microscope. Furthermore, the number of

microscopes available is insufficient, resulting in a serious shortage in the fight against malaria, particularly in developing nations[3]When opposed to qualitative microscopic diagnosis, deep learning detection of malaria is more objective and quantitative. As a result, there is a growing demand for computer-aided diagnosis, which is quick and accurate in diagnosing and performing health-related tasks. Large quantitative virus insights, annotated data sets for deep training, and learning models for disease identification have all advanced as a result of increasing uses of these automated algorithms in electronic records and imaging-based diagnosis[3][4].The second half of this study will discuss past research, the third will discuss the processes that occur prior to training, and the fourth will discuss the construction of the convolutional neural network.

## 2.Methods

This part will assist you in comprehending all of the pre-processing procedures employed in the research to record the model's various performances. This research makes use of a data set from the Kaggle website. It contains 43,827 photos of malaria parasite-infected and healthy cells. It was separated into 21900 infected cell images and 21900 infected cell images a picture of cells that haven't been infected. Figure (1) shows the structure of the suggested algorithm in a sequential manner

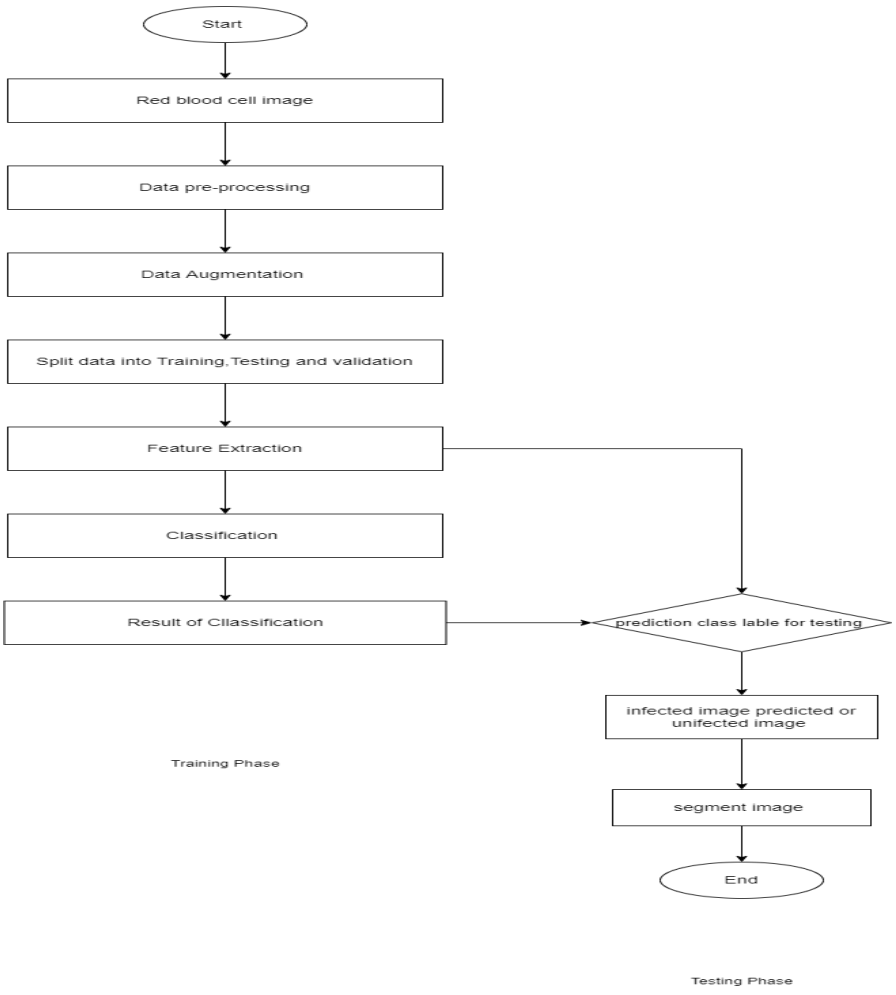
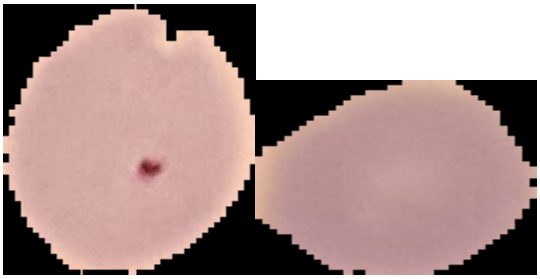



Figure .1: Block Diagram for Malaria Detection

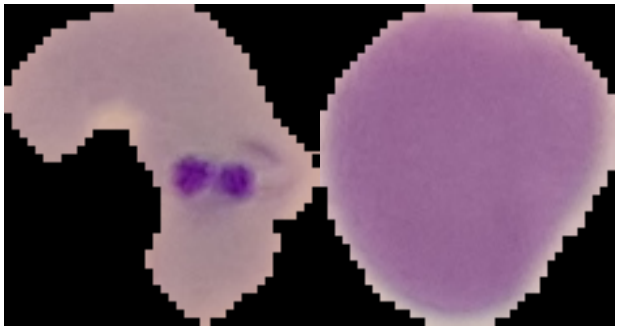
### 2.1.Re-scaling

Although image scaling improves performance, it takes a long time to compute and consumes a large amount of memory. It's ideal to keep this trade-off between accuracy and computation. All of the photographs in this study were resized to [145 145]. As a result, the classification score increased and the processing time decreased. Because the neural network gets inputs of the same size, all photographs must be scaled to a specified size before being sent to Cnn. Large images, on the other hand, require more memory space as well as a larger neural network, which takes up more space and time. Today, it's clear that choosing a specific image size involves a trade-off between computational efficiency and accuracy figure (2) shows the image of blood cell and one healthy



A. Infected 127*154 B. Uninfected 115*115

Figure.2.A. the a image of an infected red blood cell and uninfected one when the image size are different.



B. Infected B. Uninfected

Figure.2.B. the a image of an infected red blood cell and uninfected one when the image size is standardized to 145*145

### 2.2.Data splitting

After the data is collected, it is separated into three groups: training, validation, and testing. Only 70% of the data set is being used for training. Validation had a percentage of 20% and a test of 10%.

### 3. CNN Architecture

CNN is a deep learning technique for classifying images that takes the image as input, assigns learnable weights, and outputs features or objects in the image that may be used to

differentiate one from the other. The purpose of this ConvNet layer is to minimize the size of the photos to a manageable amount Build up a lot of hidden layers, but only one input and output layer.Multiple convolution layers and max pooling layers, two dense layers, one flattening layer, and the fully linked layer make up the CNN. This model is composed of four convolutional layers, each of which contains the following filters: kernel size = (3,3), padding = same, stride= (2,2), activation ("relu"), and dropout layer = (0.3). At the input layer, images were transformed to 145 × 145 x 3, with 3 denoting the channel number. The tensor was sequentially passed through (32,64,128,256) filters in each layer, starting with 32 in the first layer, and the results were satisfactory. Finally, the output neurons of the flattening layer were fed into the max pooling layer. We used a batch size of 32 and received a moderate training result after 180 epochs and 40 per epochs using the output from the dense layer as input to the activation function, which was a sigmoid activation function, in order to get the output probability of the classification task. figure 3 show Details of Layers in Deep CNN system design

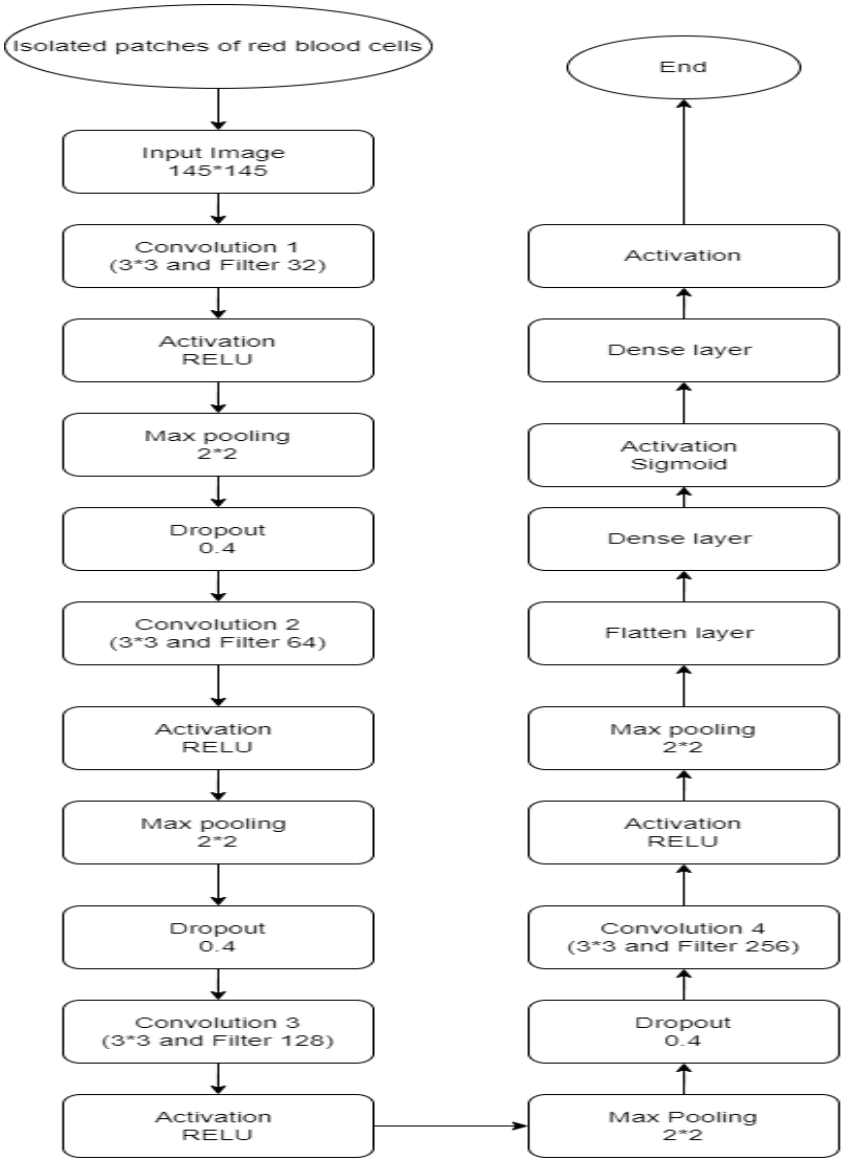



Figure 3. Convolutional Neural Network Architecture

### 3.1.convolution layer:

This is the first layer of the CNN architecture, which is used to extract picture properties. An picture is convolutioned with various filters to perform actions such as sharpening and edge detection.

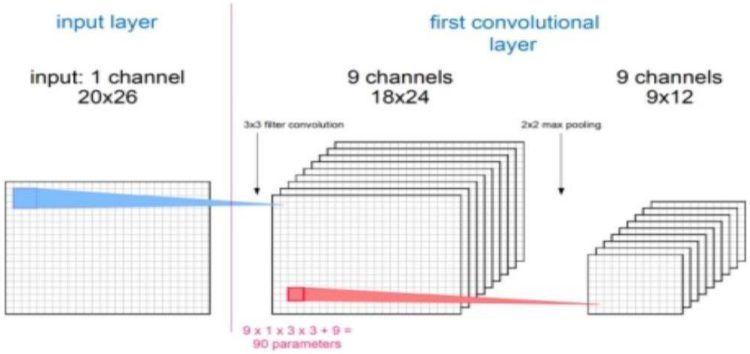



Fig.3.Example of a Convolution layer

### 3.2.Pooling layer:

When an image is too huge, this layer is used to train the algorithm to take a few numbers of parameters. There are three distinct types. The first is maximum pooling, which takes the largest element from a feature map into account. Another is Average pooling, which takes into account the average of all the components in a feature map, and Total pooling, which takes into account the sum of all the elements in a feature map.

### 3.3. ReLU Layer:

Rectified Linear Unit (ReLU) is an abbreviation for Rectified Linear Unit. It's an activation function that's applied to CNN neurons' outputs y = max is the mathematical formula for the Rectified Linear Unit (0, x).

### 3.4 Fully Connected layer:

A fully connected (FC) layer is an input feature vector. The FC layer's function is to smooth high-level properties that can be learned by Convolutional layers and merge features. It sends the resulting flattened output to the output layer.

### 4.Evaluation Metrics

The following standard metrics are used to evaluate the proposed model: accuracy, sensitivity, specificity, precision, and classification error rate. The accuracy and sensitivity parameters are utilized as metrics in the experimental setting, and the following metrics are employed as satisficing:

4.1. **Accuracy** : calculates accuracy by adding true positives and true negatives to the total number of datasets Eq. 1

$$\text{Accuracy} = \frac{\text{True positive(TP)} + \text{True Negative(TN)}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}$$

4.2. **Recall** : This is the ratio of real positive examples divided by the total number of positive cases, as calculated using the equation in Eq.2

$$\text{Sensitivity} = \frac{\text{True positive(TP)}}{\text{Actual Positive(TP} + \text{FN)}}$$

4.3. **Specificity** : The ratio of real negative to actual negative, as given by equation in Eq.3 is used to calculate specificity.

$$\text{Specificity} = \frac{\text{True Negative(TN)}}{\text{Actual Negative(FP} + \text{TN)}}$$

4.4. **Precision** : Divide the genuine positive by the projected positive using the equation in Eq.4 to find precision.

$$\text{Precision} = \frac{\text{True positive(TP)}}{\text{Predicted Positive(TP} + \text{FP)}}$$

**4.5. F1- Measure** : It's the weighted average of accuracy and recall that's been resolved. It is used to statistically assess an individual's performance. The F1 score, as previously stated, is an evaluation metric that is used to express the performance of a machine learning model by providing aggregate information on the model's accuracy and recall. Eq.5 find f1

$$\text{F1} = 2.\frac{\text{Precision} \,.\, \text{recall}}{\text{Precision} + \text{recall}}$$

Table 1. Analysis of parameters for malaria detection

| **Parameter** | Accuracy | Recall | Specificity | Precision | F1 |
|---|---|---|---|---|---|
| **Values** | 96.89 | 97.77 | 96 | 95.94 | 96.85 |

**5. Result:**

The main goal of this project is to create a useful deep learning model for predicting malaria illness. The data set used in Figure 1 in our proposed work is made up of 43,827 pictures of infected and uninfected blood cells. The data was imported from the website kaggle.com, as previously stated. The cnn model appears in the drawing where the images are classified as healthy or unhealthy in the following graph figer 3 , the validation line and the training line meet, and the model produces accurate and high results

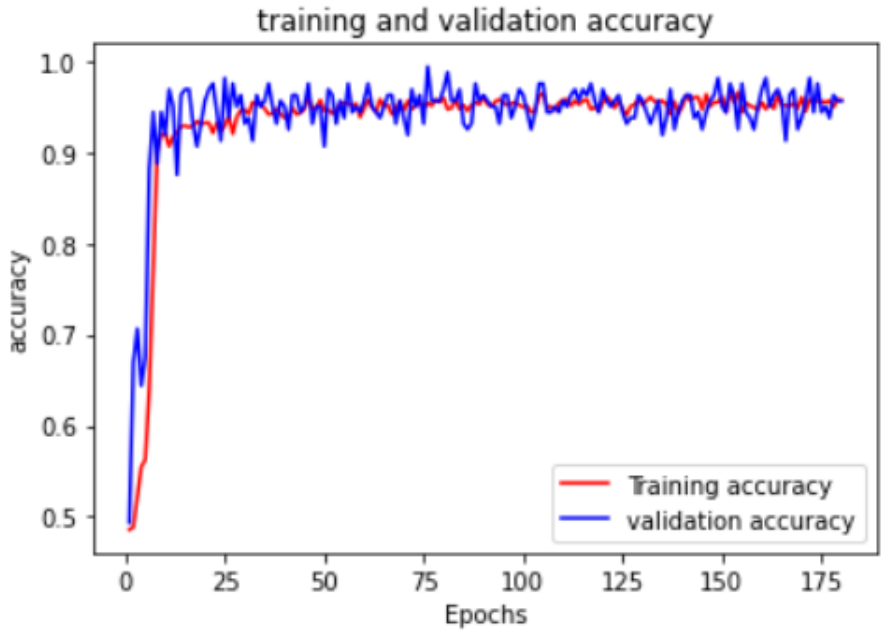



Fig.4. the accuracy graph

after which a confusion matrix is formed for each convolutional neural network for a better understanding. A two-dimensional matrix containing four attributes is used to measure machine learning classification The confusion matrix is used to generate the precision values for true positive (TP), false positive (FP), false negative, true negative(FN), and true negative(TN). Accuracy, recall, and the F-measure are all important factors to consider.

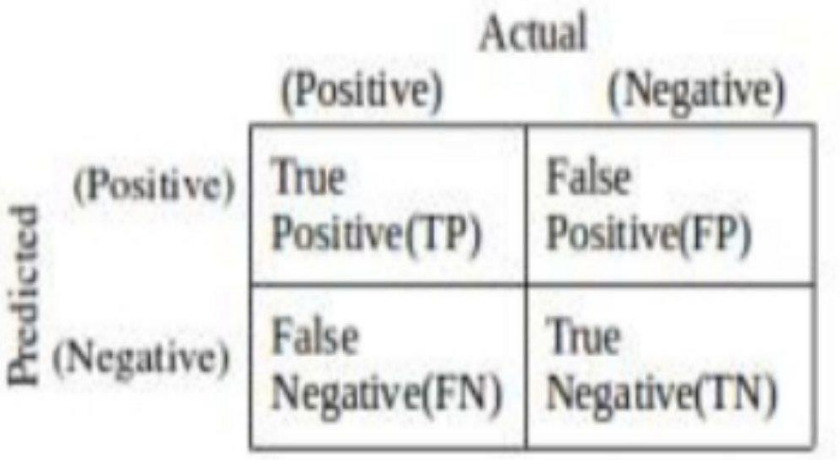



Fig 4. The confusion matrix

## 6. conclusion

Traditional methods for detecting malaria entail collecting samples and analyzing cell proliferation, which takes time and effort. In the proposed work, a deep learning model was developed to predict malaria with high accuracy and in a short amount of time. A data collection from the Kaggle.com website was used to develop and train the model by utilizing the CNN convolutional network's characteristics, and an accuracy of 96.87 was attained, demonstrating that this model is superior to other models in the future. CNN can be used to detect various disorders such as pneumonia and breast cancer.

## REFERENCES:

1. Singh, swati . Gupta, Isha. Kaur, Swapandeep .Kaur, Gurjinder (2020). Malaria detection using deep convolutional neural networks .journal 2394-5125
2. Shekar, U.G. Revathy, S . Goud, Ediga karthick (2020). Malaria detection using deep learning
3. Irmak,Emrah(2021).A novel implementation of deep learning approach on malaria parasite detection from thin blood cell images 216-224
4. Thakkar,harsh.Thakker,parth.Pede,preetish.prof.shah,nasim. Detection of malaria using machine learning.
5. Agarwal, D. A. . (2022). Advancing Privacy and Security of Internet of Things to Find Integrated Solutions. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(2), 05–08. https://doi.org/10.17762/ijfrcsce.v8i2.2067
6. Gezahegn1,Yaecob Girmay . Medhin,Yirga Hagos G.. Eneyew Adugna Etsub1 , and Tekele ,Gereziher Niguse G.(2020). Malaria Detection and Classification Using Machine Learning Algorithms
7. Nouby M. Ghazaly, M. M. A. . (2022). A Review on Engine Fault Diagnosis through Vibration Analysis . International Journal on Recent Technologies in Mechanical and Electrical Engineering, 9(2), 01–06. https://doi.org/10.17762/ijrmee.v9i2.364
8. Moranga,Collinsm., Amenga-Etego,lucas. Bah,saikou y,Appiah ,Vincent.Amuzu, dominic s.y.Amoako,Nicholas.Abugri,james.oduro,Abraham R.Cunnington,qubrey j.Awandar,Gordon a. Otto,Thomas D (2020).Machine learning approaches classify clinical malaria outcomes based on haematological parameters
9. Adamua,Yusuf Aliyu .Singh, Jaspreet (2021). MALARIA PREDICTION MODEL USING MACHINE LEARNING ALGORITHMS. Research Article .7488-7496
10. Rahman , Aimon. Zunair ,Hasib. Rahman, M sohel. Yuki, jesia quader. Biswas ,Sabyasachi .Alam , Md ashraful . Alam , nabila binte . Improving malaria parasite detection from red blood cell using deep convolutional neural networks
11. Qanbar , mohanad mohammad. Tasdemir, Sakir. (2019) Detection of malaria diseases with residual attention network 2147-6799
12. Hoda, S. A. ., and D. A. C. . Mondal. “A Study of Data Security on E-Governance Using Steganographic Optimization Algorithms”. International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 5, May 2022, pp. 13-21, doi:10.17762/ijritcc.v10i5.5548.

13. Singh, swati . Gupta, Isha. Kaur, Swapandeep .Kaur, Gurjinder (2020). Malaria detection using deep convolutional neural networks .journal 2394-5125
14. Pattanaik, P.A. Mittal ,Mohit. Khan, mohammad zubair. Panda, S.N (2020). Malaria detection using deep residual networks with mobile microscopy 1319-1578
15. Masud, mehedi. Alhumyani,hesham . Alshamrani, sultan.s. Ibrahim, Saleh. Muhammad, ghilam. Hossain, M.shamim. Shorfuzzaman, mohammed (2020).Leveraging deep learning techniques for malaria parasite detection using mobile application
16. M. Dursun and N. Goker, "Evaluation of Project Management Methodologies Success Factors Using Fuzzy Cognitive Map Method: Waterfall, Agile, And Lean Six Sigma Cases", Int J Intell Syst Appl Eng, vol. 10, no. 1, pp. 35–43, Mar. 2022.
17. Alqudah, Amin. Alqudah, Ali Mohammad. Qazan,Shoroq (2020) lightweight deep learning for malaria parasite detection using cell image of blood smear images
18. Dey,Sumagna.Nath,pradyut.Biswas,saptarshi.Nath,subhrapratim.Ganguly,ankur (2021).Malaria detection through digital microscopic imaging using deep greedy network with transfer learning . journal of medical image
19. Maqsood,Asma. Farid,Muhammad shahid. khan, Muhammad hassan. Grzegorzek,Marcin (2021). Deep malaria parasite detection in thin blod smear microscopic images.journal applied sciences 1-19
20. Abubakar,aliyu. Ajuji,mohammed.Yahya,Ibrahim usman (2021). DeepFMD: computational analysis for malaria detection in blood smear images using deep learning features.journal applied system innovation
21. Saeed, , M.M., Hasan, , M.K., Obaid, , A.J., Saeed, , R.A., Mokhtar, , R.A., Ali, , E.S., Akhtaruzzaman, , M., Amanluo, , S., Hossain, , A.K.M.Z.: A comprehensive review on the users' identity privacy for 5G networks. IET Commun. 00, 1– 16 (2022). https://doi.org/10.1049/cmu2.12327.
22. M. S. Kiran and P. Yunusova, "Tree-Seed Programming for Modelling of Turkey Electricity Energy Demand", Int J Intell Syst Appl Eng, vol. 10, no. 1, pp. 142–152, Mar. 2022.
23. Agarwal, P., Idrees, S. M., & Obaid, A. J. (2021). Blockchain and IoT Technology in Transformation of Education Sector. International Journal of Online and Biomedical Engineering (iJOE), 17(12), pp. 4–18. https://doi.org/10.3991/ijoe.v17i12.25015.
24. Azarshab M, Ghazanfari M, Heidarpoor F. An Intelligent Fuzzy Logic Based Traffic Controller. sjfst. 2021; 3 (1) :10-1, URL: http://sjfst.srpub.org/article-6-96-fa.html
25. Philip, A. M., and D. S. . Hemalatha. "Identifying Arrhythmias Based on ECG Classification Using Enhanced-PCA and Enhanced-SVM Methods". International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 5, May 2022, pp. 01-12, doi:10.17762/ijritcc.v10i5.5542.