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Identification of Kidney Related Disease Using Deep Learning

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Abstract: Nowadays, kidney stone problems are frequent, as more people are suffering from acute discomfort caused by kidney stones. The main cause of this disease is a high level of unhealthy food consumption and a low level of water consumption. Most health problems can be avoided if we drink enough water, but in this fast-paced world, people often forget to do so. As a result, stone concerns have arisen and been discovered as stone sizes have grown greater. They employ coronal computed tomography (CT) scan results and other study data on the belly and thorax to determine the sizes of stones and detect them in hospitals. This could assist in locating the issues. They currently utilize a back propagation method to assist them spot problems with an accuracy of 85 percent. We suggested deep learning methods and approaches, which process training data and data sets with labels, to find a more accurate level than the previous one. To obtain an accurate result rate, a larger number of photos are compared and analyzed with the scanned images. The accuracy level has been raised to 97.6%. So that we can acquire reliable results and diagnose problems sooner. We can observe how deep learning works and how it handles urological difficulties in this paper.

Keywords: Deep Learning, VGG16.

1. Introduction

Basically the kidney stone problem is mostly faced by the old people but at present scenario children also affected by this disease there are so many reasons for this disease to be appear in the humans if any person is not drinking the water up to the mark of the day will affected by this disease. There are so many side effects for this disease some of them are the person who affected by this disease will get the pain in stomach and some urinary bladder problems, some problems like delay of the urine and urinary bladder pain etc. To solve all this problems, we have introduced the algorithm call back propagation network using the machine learning algorithm this algorithm will detect the stones in the early stage and it will prescribe the perfect treatment for it. Since Magnetic Resonance Imaging involves noise due to subject head movement and other operator induces noises, preprocessing needs to be done to remove the noises. This algorithm is much accurate than the past algorithms. There are two types analysis present

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in this processes one is manual analysis and it is the initial method to detect the problems in the kidneys. The second processes are k-means clustering method [1], this process is mainly depending on the big data analysis it will store the all the data of the different problems in the kidneys. Basically most of the medical resonance images have the noise but in this processes we are reducing the noise in the images it will give the best output of the images and clear cut view of the stones.

2. Lıterature survey

Automatic stone identification methods [2] based on CT scan pictures and Deep learning techniques. Different cross sectional images of Coronal Computed Tomography(CT) were used for each subject, totaling 1799 images. In that comparison, they came up with a result of 96.82 percent. With a larger dataset of 433 participants, their created DL model produced higher results and is ready for clinical use. NCCT images were acquired from 500 patients with kidney stones at Elazig Fethi Sekin City Hospital in Turkey. All the images were captured with the subjects in supine position using a single scanner without using any contrast. The cross-residual network (XResNet-50) model was used to detect kidney stones. The XResNet-50 deep model was trained on raw images from the ground up.

A kidney stone detection Back Propagation Algorithm (BPA) [3] that uses machine learning approaches. Here, the method is broken down into various sections to aid with human medical support and the capture of renal images in stones. Those photographs will be given with a high pixel count and the highest level of precision in the stone region. These traditional networks provide precise findings in medical sectors such as kidney categorization and kidney stone detection in the human body. We can find the stones in their early stages and photos with no noise. The fundamental architecture is based on image processing. The main dataset is saved, and the information is sent to the training process, which will classify the processes using BPN classifiers into two categories: normal and abnormal. The kidney is normal if the condition is normal, and it is abnormal if the condition is abnormal. It will then be transferred to the FCM procedures, which will discover the kidney stone.

Deep learning for medical image analysis [4] and the architecture is divided into three sections: raw data input; deep network; and output data. Object localization utilizing deep neural network design, and training a high-performance network using varied deep learning convolution neural network methodologies with a small number of interpreted input images are the two main challenges in picture categorization and object identification. Convolutional neural network approaches were also explored in terms of their features, benefits, and applications. Deep learning systems can aid in the classification of disorders, tissue, anatomy, lesion, and tumour segmentation, lesion and tumour detection and classification, survival and disease activity prediction, as well as image production and improvement.

Utilizing a neural network [5] to detect kidney stones in CT scans using the Back-Propagation Network (BPN). GLCM is used to extract features, which are subsequently categorized using BPN. They describe the Fuzzy C-Mean (FCM) clustering algorithm, a segmentation approach for segmenting computed tomography images to detect kidney stones in their early phases. Preprocessing with GLCM feature extraction, dataset education, BPN and watershed set of rules, and kidney stone segmentation using the Fuzzy C-Means approach are all part of the procedure. The goal of this approach is to reduce the error function by modifying the load. A feed-forward multilayer neural network is trained for a series of input patterns that are identified as normal or abnormal kidneys using the set of rules. When the pattern with the input test is finished, the image is saved. The network evaluates its output response to a sample of skilled facts supplied to it as input. After that, the acquired output reaction is compared to the known and preferred output. The mistake charge is calculated. The patterns are presented to the network several times until the error is minimized.

Deep Convolutional Neural Networks for Urinary Stone Detection [6] on CT Images: Model Performance and Generalization Evaluation has been proposed and it is being utilized as input to CNN models, all DICOM pictures went through a pipeline of preprocessing algorithms. To begin, 300 HU Hounsfield unit thresholding was utilized to segment body parts. After that, the images were transformed to normal models, with all scans in the supine position. CT images with resolutions ranging from 512 to 3512 pixels were converted to grayscale and encoded as a multi window RGB image with three different

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window sizes and levels. CT images accurately recognized the presence of urinary tract stones on unenhanced abdominopelvic CT scans, according to the report's summary (area under the receiver operating characteristic curve, 0.954).

In [7], the author has proposed a Deep Learning based algorithm for Detecting Kidney Stone. The algorithm also detects the composition of kidney stones. The images used in this work are mainly from digital endoscopy. This work when used by a surgeon using Headgear can automatically deliver laser settings based on stone composition identification and increases surgical efficiency to remove stones.

In another research [8] An Efficient deep learning approach, including use of deep auto encoders is discussed. A deep auto encoder is a kind of neural network that extracts features via data-driven learning as opposed to PCA which uses analytical methods. It has been shown that accuracy of auto encoders are closed to PCA if the dataset is well balanced. RNNs (Recurrent Neural Networks) are a type of neural network that analyses data streams using hidden units. A stochastic model of neural network is called Restricted Boltzmann Machine (RBM). A Deep Beliefs Network is a deep neural network version of RBM. A model with numerous hidden layers and directionless connections between the nodes is known as a deep Boltzmann machine (DBM).

Operator errors can produce noise in magnetic resonance (MR) images are discussed in [9]. This leads to serious mistakes in image processing classifying features/diseases. Using artificial intelligence-based methods like neural networks and feature extraction to extract the region of interest using a back propagation network methodology, however, has shown significant promise in this field. The Back is featured in this piece. The purpose of the Propagation Network was to detect kidney stones. Principal component analysis is used for feature extraction, while Back Propagation Network is used for picture classification (BPN). The Fuzzy C-Mean clustering algorithm is used to create a segmentation approach in this paper. Making a decision involves two steps: 1. Extraction of characteristics 2. Image classification. The image is preprocessed, and then detection is conducted using GLCM features. The borders of the actual picture are clearly visible, which aids in enhancing the article's region of interest. This is the first step in classifying picture detection as normal or abnormal.

The FCM [10] used in this study to offer a segmentation method. Kidney Stone Detection is discussed and Artificial intelligence systems based on neural networks have shown excellent outcomes when using image processing and neural networks. Artificial intelligence techniques like neural networks have shown to be incredibly beneficial in this field. As a result, this project employs the Back-Propagation Network (BPN). The features are extracted using GLCM and then categorized using BPN. This study uses the Fuzzy C-Mean (FCM) clustering technique to segment computed tomography images in order to detect kidney stones early on. In comparison to Gabor filters, Canny Edge Detection, and Daubechies lifting algorithms, GLCM has shown enormous promise for detecting key characteristics for correct classification of kidney stones. Others result in feature reduction, which may lead to the loss of some key features.

FPGA implementation of the kidney stone detection is implemented in [11][12]. This work uses double segmentation – first segmentation is done to isolate the kidney part and the second segmentation isolates the stones from the background.

3. Proposed system

The project is about identifying kidney disease using vgg16 approach, the moles from the images is easily extracted by the convolutional layers [13][14]. The model can easily identify the disease affected by what type of disease. Here we classify 4 classes of kidney diseases [15]. After the model trained the comparison of kidney disease image and trained model takes place to predict the disease. The model executes in the below order, the image that we give is undergo pre-processing where the data augmentation and future extraction where done, then we implement our architecture which is VGG16 to our model then we compare the test and train images to predict the disease [16][17]. The flow diagram and VGG16 architecture is shown in the Fig. 1 and Fig 2.

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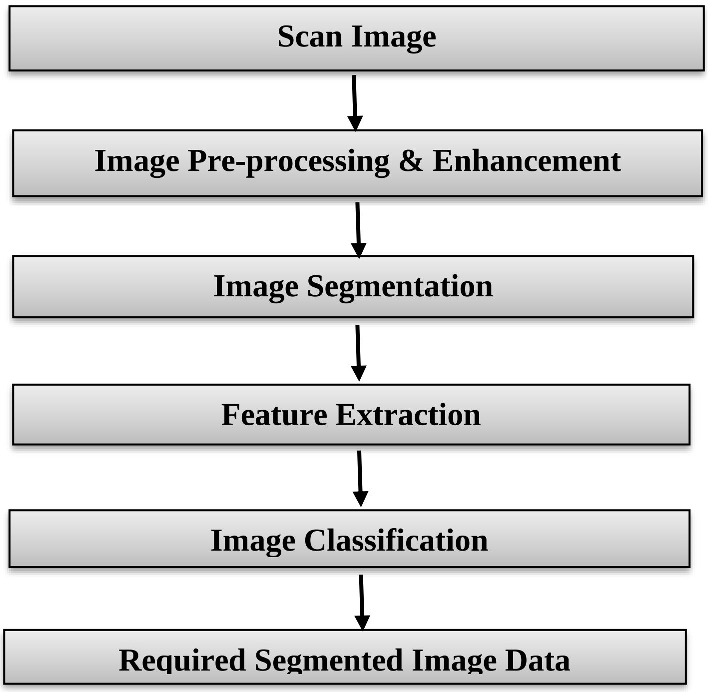

Figure 1. Flow Diagram.

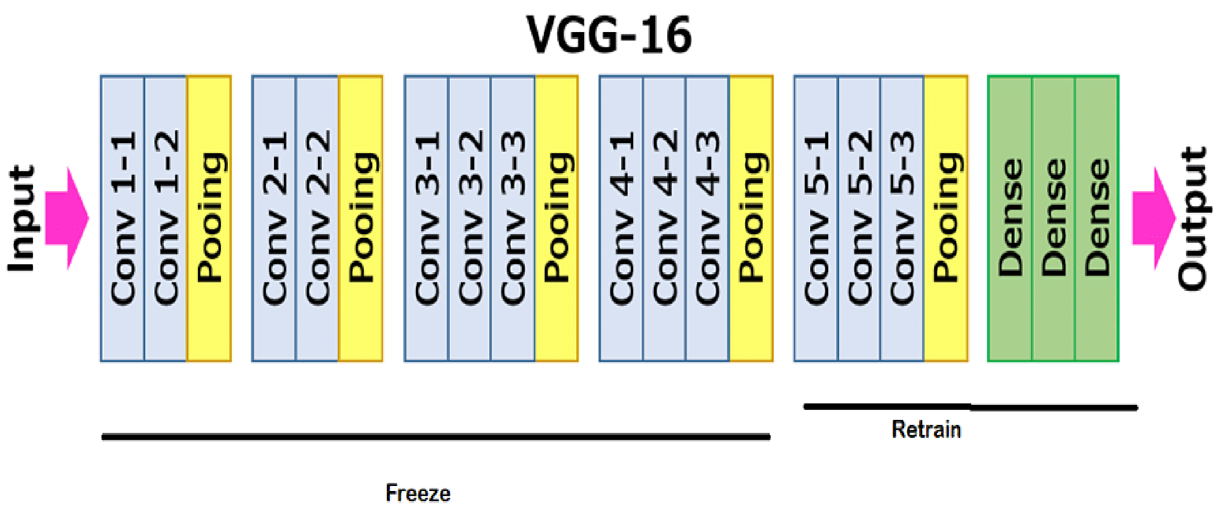

Figure 2. VGG16 Diagram.

4. Performance metrics

Accuracy :

Accuracy is a metric for deciding the classification models [18]. Accuracy is the fraction of total number of appropriate values by total number of predictions [19]. The below equation 1. is used to find the accuracy [20].

$$Accuracy = \frac{\mathrm{TP+TN}}{\mathrm{TP+TN+FP+FN}} \quad (1)$$

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F1_score :
F1_score is measured through the average of Recall and Precision and it is expressed in equation 2 [21]. F1_score is also known as F_score. It is used to calculate the accuracy of testing. It involves recall as well as precision to compute the value [22].

$$F1\_Score = \frac{2*(Recall*Precision)}{(\text{Recall}+\text{Precision})} \quad (2)$$

Recall:
Recall is also known as sensitivity refers to the fraction of values that are correctly classified by total amount of suitable instances [23]. The value of the recall is calculated as expressed in equation 3[24].

$$Recall = \frac{\text{TP}}{\text{TP+FN}} \quad (3)$$

Precision:
Precision is calculated by fraction of correctly classified values among total collected instances [25]. The value of the precision is calculated by using the equation 4[26].

$$Precision = \frac{\text{TP}}{TP+FP} \quad (4)$$

5. Experimental setup

5.1. Experimental Environment
Python – It is the high-level language that has many in build libraries. It is very simple to learn and is very effective. Currently it is used in all the advanced technologies. It has the easy access to the advanced libraries [27]. Colab- Colab is the programming platform where we can perform and execute our codes, Colab is also a google product specialized for python. It has the virtual RAM for running the program [28].

5.2. Dataset
Our dataset consists of 12446 images of 4 kidney disease, a sample images are shown in Fig 3. This is the self-arranged dataset; greater the dataset leads to the better accuracy so we use the dataset of more than 10000 images.

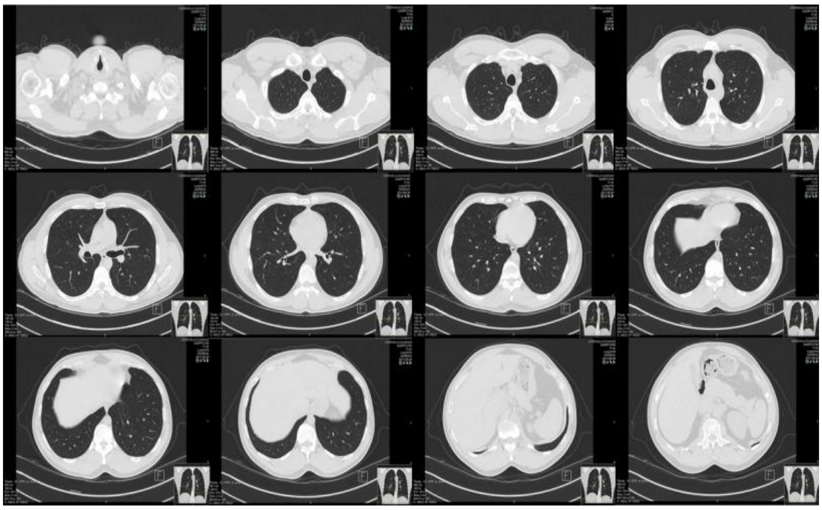

Figure 3. Dataset.

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6. Result analysis

In the training process the loss and accuracy is calculated in each iteration. Each time the accuracy gets increases and the loss gets decreases. We run an average epoch value of 5 epochs. For each epoch the accuracy of the model gets increased. We clearly seen that the accuracy of the first epoch is 55% to 77% as the number of epoch increases, the accuracy also increases, the accuracy increases from 95% to 97.6% at the end of the 5th epoch and the loss also gets reduced. Accuracy, Loss, Precision and Recall results are shown in Fig. 4.

During the validation phase, the accuracy is somewhat lower than the training accuracy 92%. This is due to less number of training samples in the dataset by increasing the number of samples by techniques like data augmentation the accuracy can be improved.

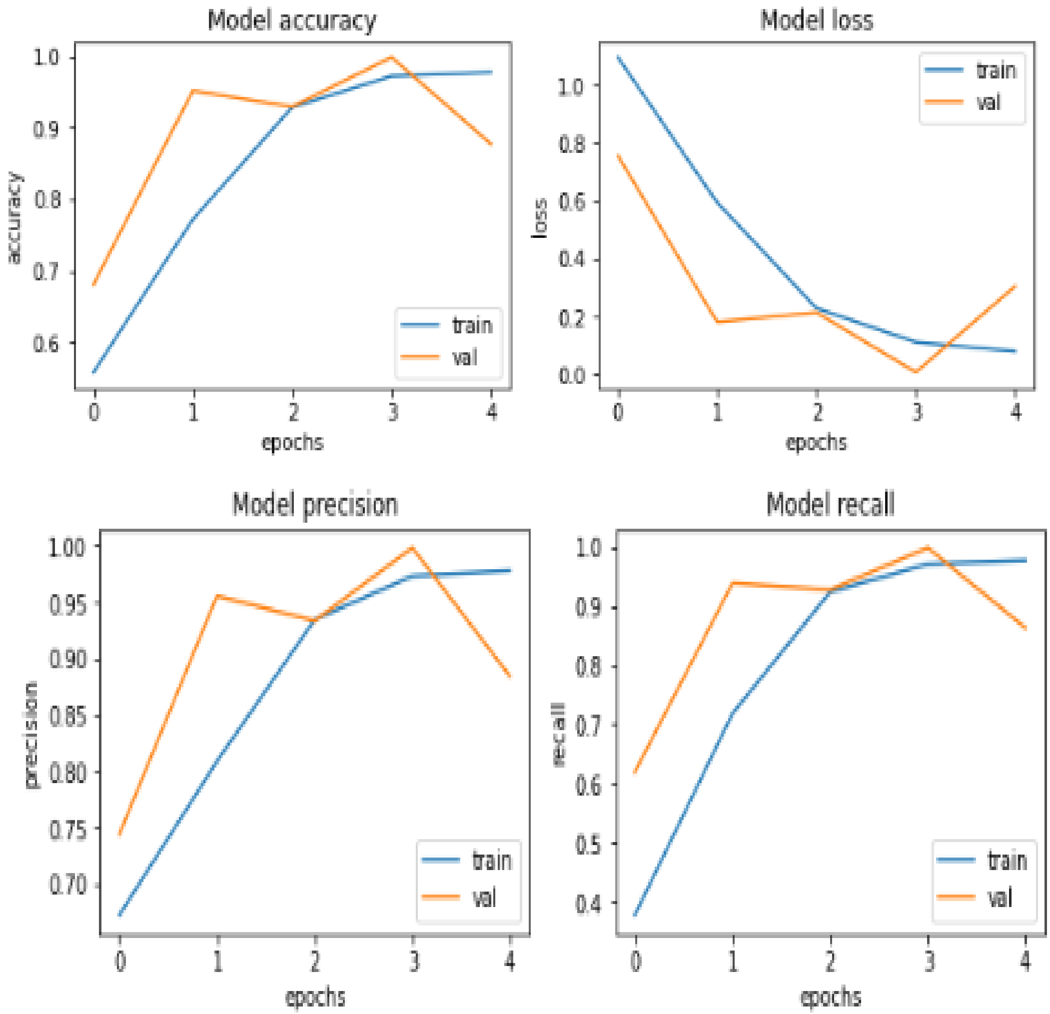

Figure 4. Result Analysis.

7. Conclusion

The findings indicate that texture characteristics can be used to distinguish kidney stones. The findings also suggest that CAD and related technologies will be developed in the future. The texture of kidney stones is used to classify them using a computer program. Choosing an appropriate research tool and formulating a decision rule by vgg16and other statistical methods will be used to examine several more videos. An appropriate judgement rule can be found using a variety of approaches

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References

[1] Hartigan, J.A. and M.A. Wong, Algorithm AS 136: A k-means clustering algorithm. Journal of the royal statistical society. series c (applied statistics), 1979. 28(1): p. 100-108.

[2] Yildirim, K., et al., Deep learning model for automated kidney stone detection using coronal CT images. Computers in biology and medicine, 2021. 135: p. 104569.

[3] Black, K.M., et al., Deep learning computer vision algorithm for detecting kidney stone composition. BJU international, 2020. 125(6): p. 920-924.

[4] Balaji, K. and K. Lavanya, Medical image analysis with deep neural networks, in Deep learning and parallel computing environment for bioengineering systems. 2019, Elsevier. p. 75-97.

[5] Mishr, R., et al., Kidney Stone Detection with CT Images Using Neural Network. International Journal of Psychosocial Rehabilitation, 2020. 24(8): p. 2490-2497.

[6] Parakh, A., et al., Urinary stone detection on CT images using deep convolutional neural networks: evaluation of model performance and generalization. Radiology. Artificial intelligence, 2019. 1(4).

[7] Black, K., et al., Deep learning computer vision algorithm for detecting kidney stone composition: towards an automated future. European Urology Supplements, 2019. 18(1): p. e853-e854.

[8] Navamani, T., Efficient deep learning approaches for health informatics, in Deep learning and parallel computing environment for bioengineering systems. 2019, Elsevier. p. 123-137.

[9] Akshaya, M., et al. Kidney Stone Detection Using Neural Networks. in 2020 International Conference on System, Computation, Automation and Networking (ICSCAN). 2020. IEEE.

[10] Viswanath, K. and R. Gunasundari, Analysis and Implementation of Kidney Stone Detection by Reaction Diffusion Level Set Segmentation Using Xilinx System Generator on FPGA. VLSI Design, 2015. 2015.

[11] Mohammed, A., E. Rachid, and H. Laamari, High level FPGA modeling for image processing algorithms using Xilinx system generator. International Journal of Computer Science and Telecommunications, 2014. 5(6): p. 1-8.

[12] Sathishkumar V E, Changsun Shin, Youngyun Cho, “Efficient energy consumption prediction model for a data analytic-enabled industry building in a smart city”, Building Research & Information, Vol. 49. no. 1, pp. 127-143, 2021.

[13] Sathishkumar V E, Youngyun Cho, “A rule-based model for Seoul Bike sharing demand prediction using Weather data”, European Journal of Remote Sensing, Vol. 52, no. 1, pp. 166-183, 2020.

[14] Sathishkumar V E, Jangwoo Park, Youngyun Cho, “Seoul Bike Trip duration prediction using data mining techniques”, IET Intelligent Transport Systems, Vol. 14, no. 11, pp. 1465-1474, 2020.

[15] Sathishkumar V E, Jangwoo Park, Youngyun Cho, “Using data mining techniques for bike sharing demand prediction in Metropolitan city”, Computer Communications, Vol. 153, pp. 353-366, 2020.

[16] Sathishkumar V E, Yongyun Cho, “Season wise bike sharing demand analysis using random forest algorithm”, Computational Intelligence, pp. 1-26, 2020.

[17] Sathishkumar, V. E., Wesam Atef Hatamleh, Abeer Ali Alnuaim, Mohamed Abdelhady, B. Venkatesh, and S. Santhoshkumar. "Secure Dynamic Group Data Sharing in Semi-trusted Third Party Cloud Environment." Arabian Journal for Science and Engineering (2021): 1-9.

[18] Chen, J., Shi, W., Wang, X., Pandian, S., & Sathishkumar, V. E. (2021). Workforce optimisation for improving customer experience in urban transportation using heuristic mathematical model. International Journal of Shipping and Transport Logistics, 13(5), 538-553.

DOI: 10.54254/2755-2721/2/20220653

[19] Pavithra, E., Janakiramaiah, B., Narasimha Prasad, L. V., Deepa, D., Jayapandian, N., & Sathishkumar, V. E., Visiting Indian Hospitals Before, During and After Covid. International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 30 (1), 111-123, 2022.

[20] Easwaramoorthy, S., Moorthy, U., Kumar, C. A., Bhushan, S. B., & Sadagopan, V. (2017, January). Content based image retrieval with enhanced privacy in cloud using apache spark. In International Conference on Data Science Analytics and Applications (pp. 114-128). Springer, Singapore.

[21] Sathishkumar, V. E., Agrawal, P., Park, J., & Cho, Y. (2020, April). Bike Sharing Demand Prediction Using Multiheaded Convolution Neural Networks. In Basic & Clinical Pharmacology & Toxicology (Vol. 126, pp. 264-265). 111 RIVER ST, HOBOKEN 07030-5774, NJ USA: WILEY.

[22] Subramanian, M., Shanmuga Vadivel, K., Hatamleh, W. A., Alnuaim, A. A., Abdelhady, M., & VE, S. (2021). The role of contemporary digital tools and technologies in Covid-19 crisis: An exploratory analysis. Expert systems.

[23] Sathishkumar, V. E., Rahman, A. B. M., Park, J., Shin, C., & Cho, Y. (2020, April). Using machine learning algorithms for fruit disease classification. In Basic & clinical pharmacology & toxicology (Vol. 126, pp. 253-253). 111 RIVER ST, HOBOKEN 07030-5774, NJ USA: WILEY.

[24] Sathishkumar, V. E., & Cho, Y. (2019, December). Cardiovascular disease analysis and risk assessment using correlation based intelligent system. In Basic & clinical pharmacology & toxicology (Vol. 125, pp. 61-61). 111 RIVER ST, HOBOKEN 07030-5774, NJ USA: WILEY.

[25] Easwaramoorthy, S., Sophia, F., & Prathik, A. (2016, February). Biometric Authentication using finger nails. In 2016 international conference on emerging trends in engineering, technology and science (ICETETS) (pp. 1-6). IEEE.

[26] Babu, J. C., Kumar, M. S., Jayagopal, P., Sathishkumar, V. E., Rajendran, S., Kumar, S., ... & Mahseena, A. M. (2022). IoT-Based Intelligent System for Internal Crack Detection in Building Blocks. Journal of Nanomaterials, 2022.

[27] Liu, Y., Sathishkumar, V. E., & Manickam, A. (2022). Augmented reality technology based on school physical education training. Computers and Electrical Engineering, 99, 107807.

[28] Rajalaxmi, R. R., Narasimha Prasad, L. V., Janakiramaiah, B., Pavankumar, C. S., Neelima, N., & Sathishkumar, V. E. (2022). Optimizing Hyperparameters and Performance Analysis of LSTM Model in Detecting Fake News on Social media. Transactions on Asian and Low-Resource Language Information Processing.