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Enhanced Detection of Brain Tumour Cells Using Visual Geometry Group

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Abstract: Deep Learning Algorithms for medical image analysis is increasing day by day, particularly in Radiology. Tumors in many parts of the body are malignant/non-malignant and should be identified as early as possible. Due to the complex structure of the brain and the existence of more noise in the scanned images, manual identification of tumors in the brain becomes harder for health care experts and it is time consuming. Hence in this proposed work, Visual Geometry Group (VGG) a classical convolution neural network(CNN) is developed in oncology to solve the problem of early identification and detection. CNN is the most effective technique for the classification of tumor and non-tumor tissues in early stage which embrace pre-processing of image followed by feature extraction, and succeeding classification. The proposed model uses VGG 16 which consists of 16 convolution layers that classifies images into 1000 different categories. It is trained and tested by using images in the BRATS dataset that shows the accuracy of about 98.75% compared to the state of art methods.

Keywords: *Brain tumor, Convolution Neural Network (CNN), Deep learning, Denoising, Visual Geometry Group(VGG).*

1. Introduction

AI (Artificial Intelligence) is the ability of the computers/robot-like devices monitored by computers to do missions. It requires human intelligence to complete the tasks humanly. Nowadays many Healthcare procedures use Artificial Intelligence in treatment protocol improvement, patient care, monitoring, etc. Artificial Intelligence achieves this through Machine learning and Deep Learning Algorithms.

Brain tumors are anomalous masses of brain tissue that constitute once cells divide rapidly faster than they ought to or fail to die when they need to. These tumors can be malignant or benign. The survival rate of cancer differs from infants to adults, country to country, based on the treatment and diagnosis. Early identification of the tumors can prevent fatalities. Tumor cell detection is done easily and effectively using Artificial Intelligence. Particularly, Deep learning techniques in Tumor cell detection provide a good result. CNN (Convolution Neural Network) model [5][6] reads the input that differentiates the tumor and non-tumor tissues and classifies it as normal or cancer. The BRATS dataset[19] that is used for training and testing the Convolution Neural Network model is largely taken into consideration[8].

The deep learning techniques [9] for image classification is VGG16. The VGG (Visual Geometry Group) is the Convolution Neural Network Architecture which consists of several layers which take the image input of size 224x224. The 16 refers to the 16 layers of the convolution layers. Moreover, this VGG16 classifies the image with nearly 1000 categories. If we go through the Convolution filter layer nearly 64 filters can be used that can double to about 128 and then to 256 filters and at the last 512 filters are used. Here the images are pre-processed with several steps and the tumors are identified. The accuracy obtained from training and validating these deep learning models is directly dependent on the quality of the input data[10]. Various factors affect the pixels of the input images. Data Augmentation [11] is the process of rectifying defective images by aligning, rotating, cropping, denoising, etc. These steps are also known as pre-processing steps[12]. Pre-processing phases play a vital role in training a deep learning model.

Considering the above motivations Visual Geometry Group (VGG) a classical convolution neural network(CNN) technique is utilized for the classification of tumor and non-tumor tissues in early stage which embrace pre-processing of image followed by feature extraction, and classification employs VGG 16 which consists of 16 convolution layers that classifies images into 1000 different categories.

2. Background

Aggregation of tissues in an abnormal manner leads to Tumors. Especially if this aggregation happens inside a brain, then it is said to be a Brain Tumor. This Brain Tumor[14][15] is

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hard to detect in its initial stages because this process of cumulation of the tissues happens swiftly. So, the patient would get into severe trouble before the medical consultant identifies the presence of a Tumor. Artificial Intelligence[21][22][24] is an emerging field of study which is applied in various sectors of day-to-day life. Deep Learning[13] is the core concept of AI which handles huge amounts of data and predicts the results of the problem using neural networks. Neural Networks are named so since it works based on the neural system of human beings. So, Brain Tumor Detection can be done from scanned images like CT scans, MRI scans, etc., and supplied into a deep learning system that once trained, predicts whether the brain contains any tumor tissues or not.

[1] proposed two pretrained CNN models for implementing transfer learning(TL) by BUS images like DenseNet201 and AlexNet undergoes preprocessing. It makes classification using the TL-based CNN models that achieves an accuracy of 92.8%. CNN (Convoluted Neural Networks) is one of the efficient neural network architectures among deep learning networks. It is a tedious job to pre-process the dataset images to feed those data into the CNN model[2]. The need to preprocess the input data is immense because it in turn affects the accuracy of the prediction of the model. Without proper preprocessing of the input data, the model cannot be trained efficiently. So pre-processing is one of the biggest factors to be carried out before training the model [3][5][23].

[4] implemented deep convolutional generative adversarial networks for generating images for three different stages of Alzheimer's disease that performs in amalgamation of brain positron emission tomography images on entirel 3 stages of syndrome. A deep learning approach for augmented cystoscopic recognition cancer in bladder was developed in [18]. Persons experiencing TURBT/cystoscopy are discovered and light videos (white) are witnessed. Frames of videos enclosing genetically incorrigible urothelial carcinoma in papillary were chosen and physically interpreted. [20][25] Implemented a thorough critical analysis of the experiments made to identify and classify brain tumor by MRI images in the latest past. This finding is particularly valuable for the researchers of deep learning principles and is concerned to pertain their proficiency for brain tumor detection and classification.

3. Purpose of Work

The proposed brain tumor detection model is to facilitate the medical professional to easily locate the tumor cells which in turn helps the patient to know about their medical status well in advance and get treated appropriately in advance. Within this, we have used the VGG16 Model to develop this brain tumor, detecting model.

. This proposed model is trained based on a dataset of MRI scanned images from which it learns how to identify whether a patient has a brain tumor or not. As it is a deep learning model, it gains knowledge from previously fed images and uses the gained knowledge to predict the output for the set next data. As a preprocessing step, we explored the preprocessing steps of an image that is to be fed into a Deep Learning Neural Network System. Among these, we analyzed the denoising preprocessing step and identified the filters which result in better quality compared to the others through some image quality metrics. The main purpose of our work is to solve a classification based problem (whether a patient has a brain tumor or not) using deep learning, to employ Data Augmentation of the Input Data before training, To build up a deep learning neural network system to analyze the MRI scanned images and forecast either the patient lives with/without Brain Tumor, to explore different Neural Network Models in deep learning, to explore the pre-processing steps in deep learning, to understand the necessity of those pre-processing steps by analyzing the accuracy and loss graph acquired by training and validating phases.

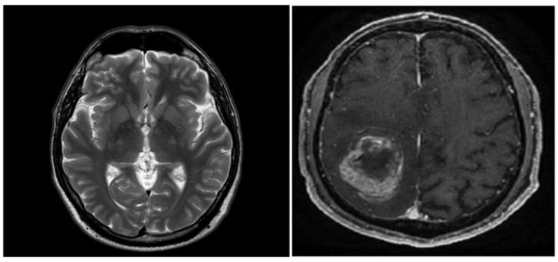
4. Proposed Methodology

Medical consultants could locate the brain tumor by analyzing the scanned images through their naked eyes. But the efficiency of identification of the Brain Tumor tissues in its earlier stages is very low compared to a deep learning model because a deep learning CNN model closely analyses every anomaly in Brain tissues by comparing the previously fed data which results in high accuracy of prediction[25]. This comparing ability is experienced out of the training and validating processes of the model. Since the entire scanned image is concentrated, any minor variations inside a normal brain can easily be captured by the model.

Figure 1 shows the scanned images of a human brain where the left side indicates a human brain with Tumour Tissues and the other side indicates the healthy normal brain of a human being. These images are usually in grayscale and the channel size is 1. Before feeding these types of images, they have to be pre-processed. Python provides a rich set of modules for the Convoluted Neural Network Architecture as well as for the pre-processing techniques.

The pre-processing steps play predominant roles in training a deep learning neural network model. The need for pre-processing steps is to make the images better suited for the neural network model to extract its features. Generally, there are various types of pre-processing steps available like Interpolation, Windowing, Denoising, Registration, etc., based on different ways of scanning the insides of humans. Among these pre-processing steps, Denoising is one of the most essential steps because this pre-processing step applies filters to the images and reduces their noise percentage[16]. Noise is just the disturbances in the pixels of an image[17].

Figure 2 depicts images of the brain with and without noises. Figure 2(b)is an appropriate and clear scanned image whereas figure 2(a)has a shortcoming called noise which affects the clearness and quality of the image which in turn reduces the accuracy of the classified output from the CNN model.



(b) Brain with Tumour cell (a) Brain without Tumour Cell

Fig. 1 . Images of brain with and without Tumour cell

To overcome these noises, we have to employ the denoising pre-processing step. In the denoising task, the image is filtered by using a different set of filters: Gaussian Filter, Median Filter, Bilateral Filter, etc. All these filters work based on a specific formula where the convoluted values of the pixels are altered using these formulae to minimize the effects of the disturbances. Specifically, there are two modules in python which has rich packages for implementing the denoising operation; they are OpenCV and Sci-Kit Modules. Through the methods available in these modules, the noisy images could be applied with a suitable filter to reduce the noise level. After minimizing the noise percentage, the quality of the image would be restored partially which increases the accuracy of the training and validating phases in deep learning models. This indicates that the model possesses the finest ability to classify the testing data.

(b) Image with Noise (a) Image without Noise

Fig. 2. Images of brain with and without Noise

5. Implementation

In the proposed model as depicted in Figure 3, as an initial step, the dataset of MRI/CT scan images of human brains. are used to train and validate the model. These scanned images must be pre-processed using different techniques to better fit into the CNN model[24].

So that the accuracy of the model would be elevated. Data Augmentation is a process of adding up the already existing forms of data with minor alterations which is helpful in the validation phase of the Neural Network. In this Data Augmentation, different alterations are made to better fit the input data into the model.

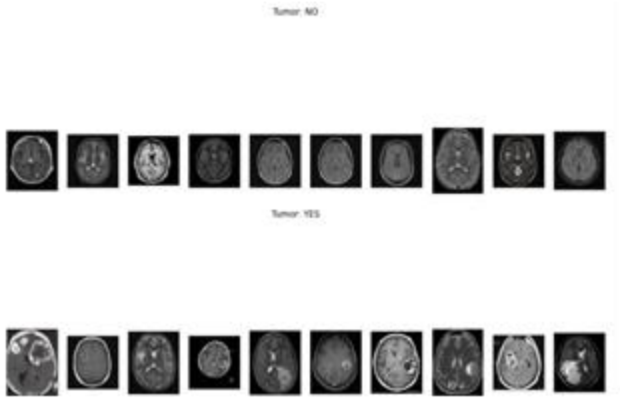


Fig. 3. MRI/CT scan images of human brains

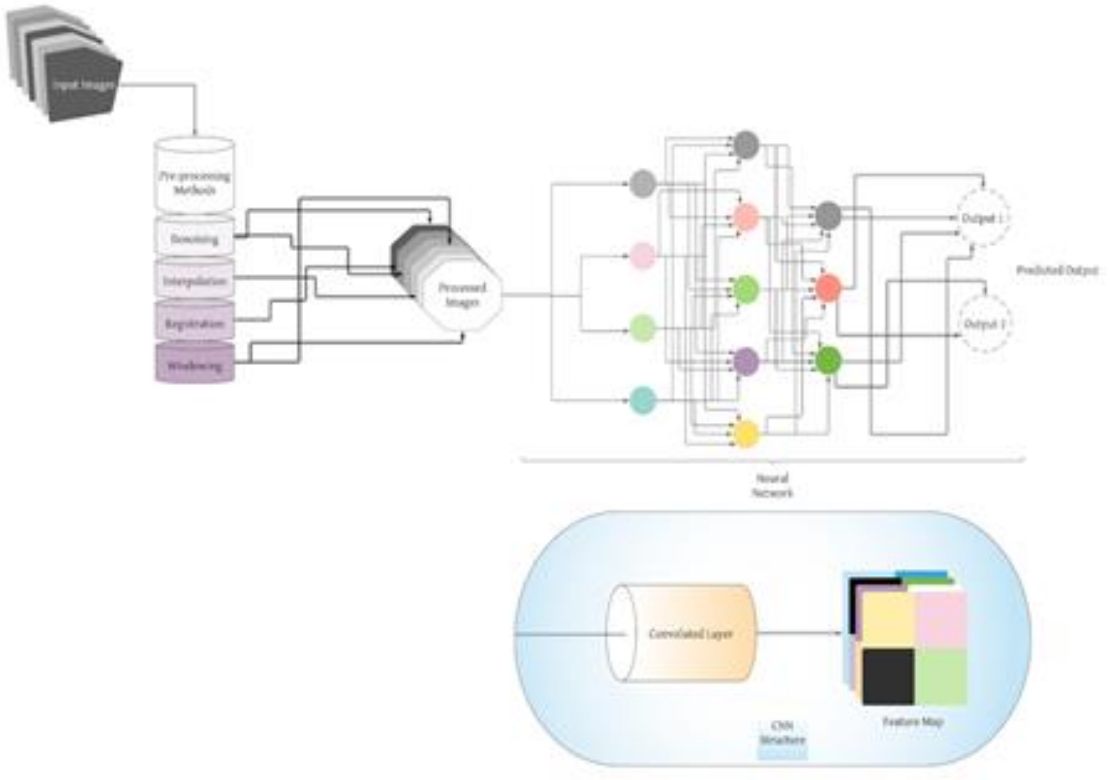


Fig. 4. Framework of the proposed system

Fig. 5. Preprocessed Images

After pre-processing the images, we should train the model using a set of images and allow the model to learn whether a scanned image of a brain contains tumor tissues or not. Segregate the images for training, validating, and testing then store them in separate directories to access individually. These pre-processed images as depicted in Fig.5 are fed into the CNN architecture (VGG-16) and trained for certain epochs which makes the model classify the input data and produce relevant output data. In between the epochs, the validation set images are fed into the neural network to predict how well the model is trained. At last, the testing set of data is fed into the model and the predicted output based on the learning from the training and validating sets are obtained.

6. Result and Discussion

The VGG16 Convoluted Neural Network model is used for this prediction of Brain Tumour cells which resulted in achieving nearly 98.75% of accuracy in training and validating the input data images as depicted in Fig.6. The training accuracy increases with the number of epochs the proposed model is trained with the same input data. and the data validation also resulted in a good accuracy level.

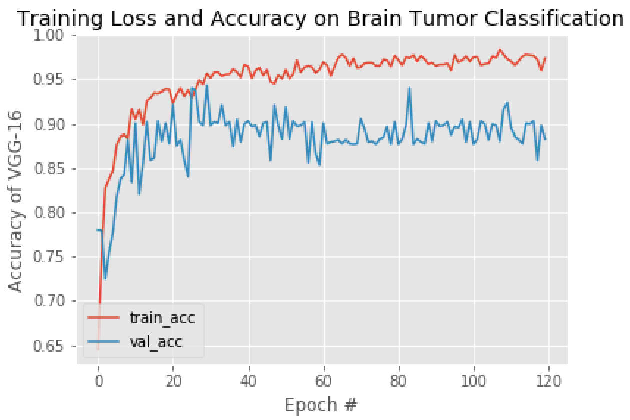


Fig. 6. Training and Validation Accuracy

The training of the model is carried out with the same set of data hence the accuracy achieved in the training phase is quite high compared to the validation phase. The input data stored in the training directory is repeatedly fed into the neural network a fixed number of times which is known as an epoch. As the same data is fed into the CNN architecture, again and again, the accuracy increases with 16 the number of epochs. To prevent overfitting, the validation set of data is introduced which would help in the betterment of the model's predictions as depicted in Fig.7.

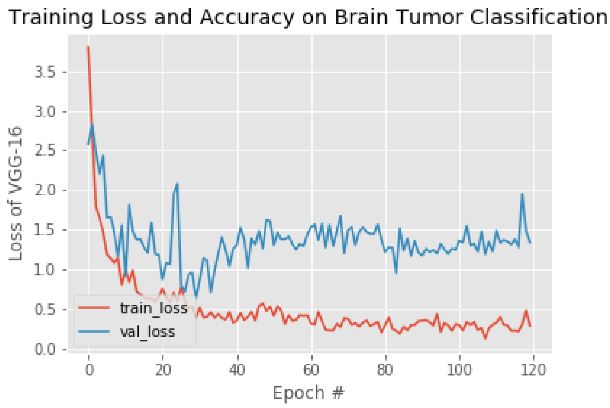


Fig. 7. Training and Validation Loss

7. Conclusion and Future Enhancements

A conclusion might elaborate on the importance of the work or suggest applications and extensions. The proposed approach utilizes Visual Geometry Group(VGG) a classical convolution neural network(CNN) in oncology is implemented to solve the problem of early identification and detection. This approach combines two main aspects i.e., the Convoluted neural network system problem with classification (toward forecasting for certain if the patient has a tumor in the brain or not) and the issue with the computer vision (to employ the practice of cropping the MRI scans automatically). This VGG16 Model provides a better accuracy rate which can be further enhanced by increasing the training and validating datasets which outcomes in enhanced training of the CNN approach.

By utilizing different CNN models like the random forest, VGG-19, ResNet, etc., we can handle more datasets and produce a better accuracy rate. Tumors and cancer tissues are threatening factors to human life can be further enhanced with. These hazardous tissues are not only found in the brain but also in major and vital organs of our body, so this deep learning model can be employed in medical scanning systems to intimate about the seriousness of the tumor tissues present in the whole body as an enhancement.

Author contributions

Dr.S.Abinaya is assigned as Corresponding Author and acts on behalf of all co-authors and ensures that questions related to the accuracy or integrity of any part of the work are appropriately addressed**.**

Dr.S.Abinaya: Conceptualization, Methodology, Writing-Original draft preparation, Software, Field study

Dr.A.Sherly Alphonse: Data curation, Writing-Original draft preparation, Software, Validation, Field study

Dr.K.Indira: Visualization, Investigation, Writing-Reviewing and Editing.

S.Karthiga: Visualization, Investigation, Writing-Reviewing and Editing.

Conflicts of interest

The authors declare no conflicts of interest.

References

[1] Tanzila Saba, Ibrahim Abunadi, Tariq Sadad, Amjad Rehman Khan, Saeed Ali Bahaj, Optimizing the transfer-learning with pre-trained deep convolutional neural networks for first stage breast tumor diagnosis using breast ultrasound visual images, Microscopy Research and Technique, 10.1002/jemt.24008, **85**, 4, (1444-1453), (2021)

[2] Yutong Zhong, Yan Piao, Guohui Zhang, Dilated and soft attention-guided convolutional neural network for breast cancer histology images classification, Microscopy Research, and Technique, 10.1002/jemt.23991, **85**, 4, (1248-1257), (2021)

[3] Amjad Rehman Khan, Siraj Khan, Majid Harouni, Rashid Abbasi, Sajid Iqbal, Zahid Mehmood, Brain tumor segmentation using K-means clustering and deep learning with synthetic data augmentation for classification, Microscopy Research, and Technique, 10.1002/jemt.23694, **84**, 7, (1389-1399), (2021).

[4] Muhammad Sajjad, Farheen Ramzan, Muhammad Usman Ghani Khan, Amjad Rehman, MahyarKolivand, Suliman Mohamed Fati, Saeed Ali Bahaj, Deep convolutional generative adversarial network for Alzheimer's disease classification using positron emission tomography (PET) and synthetic data augmentation, Microscopy Research and Technique, 10.1002/jemt.23861, **84**, 12, (3023-3034), (2021).

[5] Cao, Zhantao& Duan, Lixin& Yang, Guowu& Yue, Ting & Chen, Qin & Fu, Huazhu& Xu, Yanwu. (2017). Breast Tumor Detection in Ultrasound Images Using Deep Learning. 121-128. 10.1007/978-3-319-67434-6_14.

[6] Tariq Sadad, Amjad Rehman, Asim Munir, Tanzila Saba, Usman Tariq, Noor Ayesha, Rashid Abbasi, 6 December 2020, Brain tumor detection and multi-classification using advanced deep learning techniques, 84, 6,1296 – 1308.

[7] Masud, M., Eldin Rashed, A.E. & Hossain, M.S. Convolutional neural network-based models for diagnosis of breast cancer. *Neural Comput&Applic* (2020).

[8] Mostafa, M., Chiu, YC., Huang, Y. *et al.* Convolutional neural network models for cancer type prediction based on gene expression. *BMC Med Genomics***13,** 44 (2020).

[9] M. Siar and M. Teshnehlab, "Brain Tumor Detection Using Deep Neural Network and Machine Learning Algorithm," *2019 9th International Conference on Computer and Knowledge Engineering (ICKE)*, 2019

[10] Zilu Zhang, Yanfeng Li, Wen Wu, Houjin Chen, Lin Cheng, Shu Wang, Tumor detection using deep learning method in automated breast ultrasound, Biomedical Signal Processing and Control, Volume 68,2021.

[11] Heba Mohsen, El-Sayed A. El-Dahshan, El-Sayed M. El-Horbaty, Abdel-Badeeh M. Salem, Classification using deep learning neural networks for brain tumors, Future Computing and Informatics Journal, Volume 3, Issue 1, 2018, Pages 68-71.

[12] JOUR, Yasaka, Koichiro, Akai, Hiroyuki, Kunimatsu, Akira, Kiryu, Shigeru, Abe, Osamu, 2018/04/01, Deep learning with convolutional neural network in radiology Japanese Journal of Radiology, 36, 4

[13] S. Albani, T. A. Mohammed, and S. Al-Zawi, "Understanding of a convolutional neural network," *2017 International Conference on Engineering and Technology (ICET)*, 2017, pp. 1-6.

[14] R. Ezhilarasi and P. Varalakshmi, "Tumor Detection in the Brain using Faster R-CNN," 2018 2nd International Conference on I-SMAC (IoT in Social, Mobile, Analytics, and Cloud) (I-SMAC)I-SMAC (IoT in Social, Mobile, Analytics, and Cloud) (I-SMAC), 2018 2nd International Conference on, 2018.

[15] Rui Zhang, Chao Cheng, Xuehua Zhao, Xuechen Li, Multiscale Mask R-CNN–Based Lung Tumor Detection Using PET Imaging, July 31, 2019.

[16] K. Zhang, W. Zuo, Y. Chen, D. Meng, and L. Zhang, "Beyond a Gaussian Denoiser: Residual Learning of Deep CNN for Image Denoising," in *IEEE Transactions on Image Processing*, vol. 26, no. 7, pp. 3142-3155, July 2017.

[17] M. J. Traum, J. Fiorentine. (2021). Rapid Evaluation On-Line Assessment of Student Learning Gains for Just-In-Time Course Modification. Journal of Online Engineering Education, 12(1), 06–13. Retrieved from http://onlineengineeringeducation.com/index.php/joee/article/view/45

[18] Chun Wei Tian, Lunke Fei, Wenxian Zheng, Yong Xu, WangmengZuo, Chia-Wen Lin, Deep learning on image denoising: An overview, Neural Networks, Volume 131, 2020, Pages 251-275.

[19] Eugene Shkolyar, Xiao Jia, Timothy C. Chang, Dharati Trivedi, Kathleen E. Mach, Max Q.-H. Meng, Lei Xing, Joseph C. Liao, Augmented Bladder Tumor Detection Using Deep Learning, European Urology, Volume 76, Issue 6, 2019, Pages 714-718, ISSN 0302-2838.

[20] Tanzila Saba, Ahmed Sameh Mohamed, Mohammad El-Affendi, Javeria Amin, Muhammad Sharif, Brain tumor detection using fusion of hand crafted and deep learning features, Cognitive Systems Research,Volume 59, 2020, Pages 221-230, ISSN 1389-0417.

[21] Yadav, P. ., S. . Kumar, and D. K. J. . Saini. “A Novel Method of Butterfly Optimization Algorithm for Load Balancing in Cloud Computing”. International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 8, Aug. 2022, pp. 110-5, doi:10.17762/ijritcc.v10i8.5683.

[22] Maria Nazir, Sadia Shakil, Khurram Khurshid,Role of deep learning in brain tumor detection and classification (2015 to 2020): A review, Computerized Medical Imaging and Graphics, Volume 91, 2021, 101940, ISSN 0895-6111.

[23] Abinaya, S., & Devi, M. K. (2021). Enhancing top-N recommendation using stacked autoencoder in context-aware recommender system. Neural Processing Letters, 53(3), 1865-1888.

[24] Abinaya, S., & Kavitha Devi, M. K. (2022). Trust-Based Context-Aware Collaborative Filtering Using Denoising Autoencoder. In Pervasive Computing and Social Networking (pp. 35-49). Springer, Singapore.

[25] Paithane, P. M., & Kakarwal, D. (2022). Automatic Pancreas Segmentation using A Novel Modified Semantic Deep Learning Bottom-Up Approach. International Journal of Intelligent Systems and Applications in Engineering, 10(1), 98–104. https://doi.org/10.18201/ijisae.2022.272

[26] Abinaya, S., & Devi, M. K. (2022). Enhancing crop productivity through autoencoder-based disease detection and context-aware remedy recommendation system. In Application of Machine Learning in Agriculture (pp. 239-262). Academic Press.

[27] Chaudhary, D. S. . (2022). Analysis of Concept of Big Data Process, Strategies, Adoption and Implementation. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(1), 05–08. https://doi.org/10.17762/ijfrcsce.v8i1.2065

[28] Abinaya, S., Kavitha Devi, M. K., & Sherly Alphonse, A. (2022). Enhancing Context-Aware Recommendation Using Hesitant Fuzzy Item Clustering by Stacked Autoencoder Based Smoothing Technique. International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 30(4), 595-624.

[29] S.Abinaya and T.Rajasenbagam (2022), Enhanced Visual Analytics Technique for Content-Based Medical Image Retrieval. IJEER 10(2), 93-99. DOI: 10.37391/IJEER.100207.