Grenze International Journal of Engineering and Technology, Jan Issue

Revolutionizing Cancer Detection through AI Algorithms

Dr. Nidhi Srivastava[1]
[1]AIIT, Amity University, Lucknow, India
Email: nsrivastava2@lko.amity.edu

***Abstract*— Artificial Intelligence (AI) is a field which has spread its wing everywhere. The two subsets of AI – Machine Learning (ML) and Deep Learning (DL) are very much in demand nowadays. Use of AI in healthcare is now seen at a large scale. One of the prominent uses of AI algorithm is in detection of cancer. The number of cancer cases is increasing rapidly and both doctors and researchers are trying to find a solution for the same. Detection of cancer is possible through various tests like MRI, CT scan, etc. It is a challenge for the doctors to interpret the tests correctly as it is very complex and time-consuming. It becomes even more challenging to infer the tests if the cancer is in the early stage. This is where AI can help. Various ML/ DL algorithms can be used to speed up the detection process and thus identify cancerous cells in the initial stage so that the survival rate of the patient increases. Early diagnosis and timely intervention can make a significant difference between life and death for cancer patients. This paper briefly outlines the role of AI including ML and DL in cancer detection and how various researchers are using it for prediction of disease. The paper also outlines the general steps used in AI for detection of cancer.**

***Index Terms*— Artificial Intelligence, Cancer, Deep Learning, Detection, Diagnose, and Machine Learning**

I. INTRODUCTION

Cancer is the most dreaded disease in today's world. According to the World Health Organization in 2020, 10 million deaths were due to cancer which is approximately one in six deaths [1]. The word cancer has been derived from the Greek word kapkivoc meaning crab and tumor [2]. Basically, it is a disease in which unwanted and abnormal cells grow and spread in the human body causing problems. These abnormal cells can grow anywhere in the body and can also lead to tumors in some cases. This disease is critical because it is very difficult to detect cancer in an early stage and it advances at a very rapid and fast pace. Since the detection is at a later stage its cure becomes problematic and increases the risk to the life of the patient. There are many types of cancer depending on the area of growth of unwanted cells in the body [2, 3]. Most cancers have tumors. These tumors can be malignant or benign. A benign tumor is non-cancerous, but a malignant tumor is cancerous. Some of the common cancers are lung cancer, cervical cancer, throat cancer, breast cancer, skin cancer, etc. Early detection of cancer increases the survival rate and the quality of the life of the patient. Thus, the timely diagnosis of cancer becomes crucial. Various tests like MRI, PET Scans, etc. are available which help in the diagnosis of cancer, but still till now the early detection of cancer is very complicated. With the rapid growth of Artificial intelligence, researchers are trying to reap its benefits for detection of cancer at an early stage [3]. In this paper section I describe AI, ML and DL. Section II lists various applications of AI in healthcare including cancer. Section III explains the various ways

Grenze ID: 01.GIJET.10.1.47

in which researchers have used AI in cancer detection. Section IV outlines the various tests for detection of cancer. Section V gives the general steps used for identifying the cells as benign or malignant by using AI algorithms. Finally, section VI gives the conclusion.

II. AI/ML/DL

AI is a field of computer science where the machines are trained to simulate the behavior of humans. These systems can be compared to the human intelligent system. Basically, it deals with intelligent agents which can take decisions on their own depending on the situation [4]. It was developed around 1950. Various applications where AI is used are speech recognition, robotics, simulators, healthcare, manufacturing, etc. [5,6].
ML is a subset or a branch of AI which tends to learn from the data provided to it. The term was first coined by Arthur Samuel in 1959. Through different algorithms it is capable of learning from the past data and then making predictions even for something for which it is not actually programmed for [7]. The ML algorithms can be classified into Supervised, Unsupervised and Reinforcement learning. [8,9, 10]
Supervised algorithms are the algorithms where the algorithms are trained using labelled data and the correct output is tagged with the input data. The system tends to learn through this process and thus when the testing data is given to the system it can easily classify it. Supervised algorithms can be classified as regression and classification problems. Common supervised algorithms include Random Forest, Decision Tress, Linear regression, polynomial regression, support vector machines, logistic regression, etc. [9, 10]
Unsupervised algorithms are where the data is unlabeled and the system is not guided. The system needs to train itself on its own. The algorithm finds the patterns in the data, group accordingly and then classify it on its own. This is more relatable with real data where every input data is not connected with the output. Unsupervised algorithms can be classified into clustering and association. Common unsupervised algorithms used are K- means clustering, Principal component analysis, K-means clustering, Neural networks, Apriori algorithm, etc. [9,10]
Reinforcement Learning is a type of learning based on feedback. The system has a specified objective and learning is carried out. Based on the action taken by the system, the environment gives feedback in terms of reward or punishment and thus the agent learns or unlearns. Thus, by reinforcement the agent interacts with the environment and trains itself based on it. [10, 11, 12]
Deep Learning – It is a subset of AI and ML. It is widely used nowadays. It is based on Artificial Neural Network (ANN) and uses multiple layers of networks to process which are more precise and are more accurate. In this the weights are applied to the given inputs. These weights adapt to the given situation and thus by learning produce output which is precise and accurate. Common DL algorithms include recurrent neural network, Convolutional Neural Network (CNN), Restricted Boltzman machine, etc. [8,9,10, 13]. Figure 1 shows the association between artificial intelligence, machine learning and deep learning. [14]
The above different ML/DL algorithms can be used for the prediction and early diagnosis of cancer.

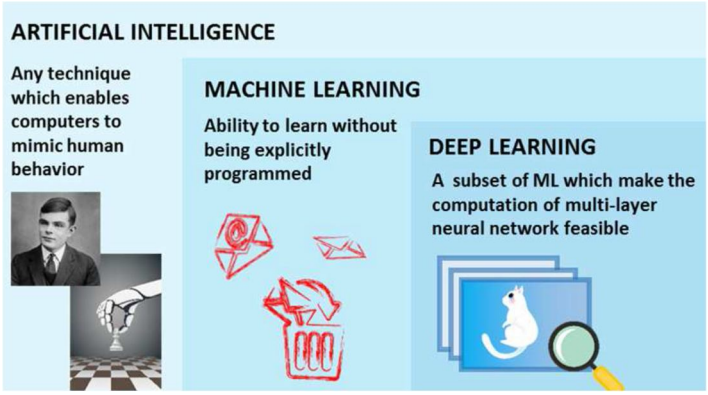

Figure 1: AI, ML and DL [14]

III. Medical Tests For Detection Of Cancer

There are various tests which are performed for detection of cancer and on the basis of these tests the doctor decides whether the person is suffering from cancer or not. The type of test used will depend on the specific type of cancer being screened for, as well as other factors such as the patient's age and medical history. The common tests that are conducted are certain lab tests which are based on sputum, urine and blood samples. Some of these tests are blood chemistry test, complete blood count, immune phenotyping, cytogenetic analysis, sputum cytology,

immune phenotyping, liquid biopsy, tumor marker tests, urinalysis, etc. Then there are tests which are based on imaging techniques like Magnetic Resonance Imaging (MRI), Computed Tomography (CT) scan, nuclear test, bone scan, mammography, Positron Emission Tomography (PET) scan, ultrasound, Magnetoencephalography (MEG) and X rays. There are certain other tests like Pap test, Colonoscopy, Prostate-specific Antigen (PSA) test which are recommended depending upon the location and screening of the cancer type. Then doctor also recommends biopsy wherein a part of the abnormal cell is extracted and various tests are performed on it and then determine the presence of cancer or not [1, 15]. Fig. 2 lists some of the tests advised by doctors for detection/diagnosis of cancer.
Interpreting and figuring out the problems in the report of the above tests is a complicated task which only a competent and experienced doctor can comprehend, especially in the cases where the cancer is in its early stage. ML and DL algorithms applied on the above tests, especially on the imaging tests, give an accurate result as discussed in the literature review section.

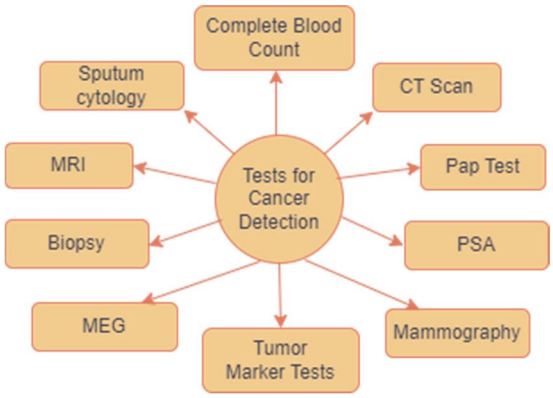

Figure 2: Various Tests conducted for detection of cancer.

These algorithms increase the chance of timely detection of cancer for further treatment. Section V describes how AI is being used by researchers for cancer detection.

IV. AI Use In Healthcare

AI, ML and DL play an important role in delivering better healthcare facilities. In fact, ML/DL algorithms are helping medical professionals in medical research. After COVID-19 the use of AI even further increased, and it pushed its development. AI is being used in drug discovery. To predict about the cancer drugs, The Institute of Cancer Research's canSAR database is making use of AI. Use of AI is also seen in clinical care. It can be used for the detection of the coronary heart disease, parkinson's disease, eye diseases, pneumonia. AI controlled robotic tools help in surgery. Minute precision work can be done with the help of robots [16].
AI's use can be seen in biomedicine also. The quality of life for elderly and differently abled persons can be improved with AI. Human facial expressions can be taken by these people to give the commands. A fall detection system can be built with AI for elderly people which can warn the concerned persons about their fall and timely action can be taken [4].
AI/ML also plays a major role in cancer treatment. Timely detection of cancer is very important so that its growth can be controlled within the time frame, thus leading to increasing the longevity of the person. AI algorithms can analyze medical images, such as X-rays, MRI scans, and CT scans, to detect abnormalities that could indicate the presence of cancer. AI algorithms can be trained to identify tumors from tissue samples or biopsies, even in cases where the tumors are difficult to detect by human pathologists. AI algorithms can also analyze patient data, such as medical history and genetic information, to identify patients who are at higher risk of developing cancer. This can help doctors to catch the disease in its early stages, when it is easier to treat. It can also help in the prediction of the survival rates of cancer patients. Google and IBM are making advancements in this field by using AI. In fact, they have started some good initiatives like Google DeepMind [17], IBM's Watson for Oncology, The Digital Mammography DREAM challenge, BERG Health [18] to name a few.

V. Related Study

[19] in the paper have highlighted the point that whatever the stage of the cancer the line of treatment is same for all individuals irrespective of their differences. The author has used deep learning and given new personalized

methods of treatment to the patients. Firstly, the author has discussed the three algorithms traditionally used i.e., reinforcement learning, distributed reinforcement learning and deep reinforcement learning. The author has then made use of non-invasive external diaphragm pacer (EDP) and used AI chip for lung cancer for controlled inhaled nano drug delivery system.

[20] in their work have taken lung cancer images and applied image enhancement techniques using Gabor Method. Then watershed method of image segmentation has been done. Thereafter feature extraction using binarization approach has been applied and finally lung cancer has been detected using Artificial Neural Network. Back propagation neural network has been used and found to be successful in classification of the images as no cancer, stage 1 lung cancer or stage 2 lung cancer.

[21] have talked about skin cancer and emphasized the importance of early detection and diagnosis of skin cancer. HAIS (Health Care AI Solutions) has given a solution for the same with reference to the Indian sub-continent. They have designed a system wherein the patient's detail with all medical records are stored as soon as the patient comes to the hospital. Thereafter the skin images captured by doctors are uploaded on the IT platform. These images are then processed by AIML module which thereby predicts about the skin cancer and the risk levels. This tool is beneficial for the dermatologist in the prediction of the skin cancer.

[22] have emphasized on the importance of brain imaging technology which shows the anatomy of the brain in detail and thus helps in medical diagnosis. The authors have used convolutional neural network (CNN) and spark stacked auto encoder on brain MRI images for detection of the cancer. The results show that the proposed method by the authors outperforms the Deep Wavelet Auto-encoder deep Neural Network (DWA-DNN)

[23] have also used MRI brain images for classification of brain tumor. They have used hybrid deep convolution neural network and deep watershed auto-encoder (CNN-DWA) model for the same. Compared to other models like CNN, DWA and DNN this model gave more accuracy in the prediction, detection and classification of the brain tumor. Thus, it will help the doctors in prediction of cancer and its timely treatment.

[24] have talked about breast cancer. The authors have proposed a model for early breast detection. They have used Inception_ResNet_V2 model for assessment of breast density in radiographs. A problem with deep learning models is that a large dataset is needed for training purposes. But this particular DL model worked well even in the deficiency of data and gave very high accuracy result.

Table 1 shows the different algorithms/ methods used by the researchers to detect different types of cancer/tumors.

TABLE I: ALGORITHMS AND DATASETS USED FOR DETECTION OF DIFFERENT CANCERS

Reference	Year	Type of Cancer	Dataset	Algorithm	Accuracy
25	2015	Brain cancer	BRATS -2015	Proximal support vector machine (PSVM)	92 %
26	2021	Skin cancer	Dataset collected from ISIC (International Skin Imaging Collaboration)	SVM algorithm	96.9%
27	2022	Image cancerous or not	Two datasets: 1.Breast cancer Wisconsin dataset 2. Breast Histopathology images dataset (biopsy cell image)	Architecture ResNet-50	91.7%
28	2022	Lung, Colon, and (Lung and Colon) cancer	Histopathological (LC25000) lung and colon datasets	Deep feature extraction and ensemble learning with high-performance filtering	Lung - 99.05%, colon -100%, and (lung and colon) cancer - 99.30%,
29	2023	Brain tumor	J. Cheng. Figshare Brain tumor dataset	Ensemble deep convolutional neural network (EDCNN)	97.77%.
30	2023	Lung cancer	Kaggle chest CT-scan images dataset	Deep Learning (DL) based method was used by modifying the DenseNet201 model	High accuracy of 100%, an average accuracy of 95%

VI. General Steps For Detection Of Cancer

Machine learning models trained on patient medical history data can analyze millions of patient records and flag patients who are more likely to develop cancer. This AI application in early detection of cancer can massively improve patient outcomes by allowing physicians to take a proactive approach to cancer prevention. While using ML/DL techniques there are certain steps which generally are followed for diagnosing cancer. Fig. 2 shows the general steps and thereafter each step is described below.

Image Acquisition – In this the image of the particular area where abnormal cells or tumor are anticipated is acquired from various sources and the dataset is formed. There are many different datasets available online for cancer. There are cancer datasets for lung, breast, skin, etc. available on Kaggle [31], UCI [32], etc. which can be used. However, sometimes the researchers prefer taking the images from the hospitals and create a dataset of their own for use.

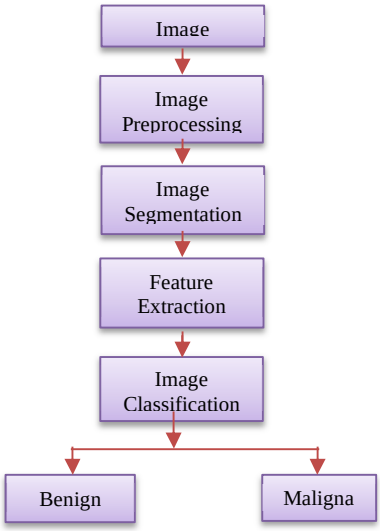

Figure 3. General steps in cancer detection

Image Pre-processing – It deals with pre-processing of images. Pre-processing includes resizing of images, removal of noise, contrast enhancement, orientation, etc. The Images generally acquired cannot be used as such due to disturbance in them and need to be cleaned and formatted for further use. The images obtained using X ray, MRI, CT scan are pre-processed using various techniques so that it can be easily used.

Image Segmentation – Under this, the image is divided into smaller parts so that the complexity of the image is reduced. Various mathematical morphological operations are used for segmenting of the image. It helps the doctors in identifying and quantifying the volume of the tissue which helps in identifying the tumor [33].

Feature Extraction – It is a process in which the unwanted features are removed thus reducing the number of features. This extraction of features is done on the basis that these features maximize the chance to classify the data easily. Since the dimensionality of the data is reduced it improves the classification accuracy and identifying helps in diagnosing of the cancer easily [34]

Classification – The last step is classification. In this there are predefined classes, and images are labelled into these classes. Classification techniques are used to classify the images in one of the classes. In our case the image is to be classified as benign or malignant.

AI algorithms have shown great promise in cancer detection. Recent research has shown that machine learning models can process large amounts of genomics and proteomics data to accurately detect cancerous cells. Specifically, AI tools can analyze gene expression, biomarker presence, and drug interactions to provide personalized cancer therapy to individual patients.

VII. Conclusions

Cancer is one of the topmost diseases which causes death worldwide. However, it is difficult to identify or detect cancer at a very initial state when it is curable. Generally, when the cancer reaches is at high grade, it can be detected. AI/ML techniques can facilitate this. Artificial Intelligence has tremendous potential to revolutionize and reshape the healthcare industry by transforming the way health care providers diagnose and treat cancer patients.

Using different ML techniques/algorithms the prediction accuracy of cancer can be improved. This will help in the timely treatment of the patients and increase the life expectancy of the patient. In this paper we have highlighted the general steps for diagnosing cancer using AI. The future of cancer detection and diagnosis will rely heavily on AI technology. However, further research is needed to determine the most effective AI tools for the early detection and personalized treatment of cancer patients.

REFERENCES

[1] https://www.who.int/en/news-room/fact-sheets/detail/cancer.

[2] Kumar, Y., Gupta, S., Singla, R. et al. A Systematic Review of Artificial Intelligence Techniques in Cancer Prediction and Diagnosis. Arch Computat Methods Eng 29, 2043–2070 (2022). https://doi.org/10.1007/s11831-021-09648-w

[3] S. Gupta, A. Gupta and Y. Kumar, "Artificial intelligence techniques in Cancer research: Opportunities and challenges," 2021 International Conference on Technological Advancements and Innovations (ICTAI), Tashkent, Uzbekistan, 2021, pp. 411-416, doi: 10.1109/ICTAI53825.2021.9673174.

[4] Guoguang Rong, Arnaldo Mendez, Elie Bou Assi, Bo Zhao, Mohamad Sawan, "Artificial Intelligence in Healthcare: Review and Prediction Case Studies,Engineering, Volume 6, Issue 3, 2020, pp: 291-301, ISSN 2095-8099, ttps://doi.org/10.1016/j.eng.2019.08.015

[5] Bahiru Legesse Jimma, Artificial intelligence in healthcare: A bibliometric analysis, Telematics and Informatics Reports, Volume 9, 2023, 100041, ISSN 2772-5030, https://doi.org/10.1016/j.teler.2023.100041

[6] A. Koul, Y. Kumar and A. Gupta, "A Study on Bladder Cancer Detection using AI-based Learning Techniques," 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), Tashkent, Uzbekistan, 2022, pp. 600-604, doi: 10.1109/ICTACS56270.2022.9988462.

[7] Awad, M., Khanna, R. (2015). Machine Learning. In: Efficient Learning Machines. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4302-5990-9_1

[8] N. Srivastava, "Analyzing the Suitability of Deep Learning Algorithms in Edge Computing", Book, Applications of Artificial Intelligence, Big Data and Internet of Things in Sustainable Development, 2022

[9] Sarker, I.H. Machine Learning: Algorithms, Real-World Applications and Research Directions. SN COMPUT. SCI. 2, 160 (2021). https://doi.org/10.1007/s42979-021-00592-x

[10] A.Chahal, P.Gulia "Machine Learning and Deep Learning", International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

[11] M. Naeem, S. T. H. Rizvi and A. Coronato, "A Gentle Introduction to Reinforcement Learning and its Application in Different Fields," in IEEE Access, vol. 8, pp. 209320-209344, 2020, doi: 10.1109/ACCESS.2020.3038605.

[12] Reinforcement Learning: An Introduction, Richard S. Sutton and Andrew G. Barto

[13] Sarker, I.H. Deep Learning: A Comprehensive Overview on Techniques, Taxonomy, Applications and Research Directions. SN COMPUT. SCI. 2, 420 (2021). https://doi.org/10.1007/s42979-021-00815-1

[14] Shigao Huang, Jie Yang, Simon Fong, Qi Zhao, Artificial intelligence in cancer diagnosis and prognosis: Opportunities and challenges, Cancer Letters, Volume 471, 2020, pp 61-71, ISSN 0304-3835, https://doi.org/10.1016/j.canlet.2019.12.007

[15] https://www.cancer.gov/about-cancer/diagnosis-staging/diagnosis

[16] https://www.nuffieldbioethics.org/assets/pdfs/Artificial-Intelligence-AI-in-healthcare-and-research.pdf

[17] Powles J, Hodson H. Google DeepMind and healthcare in an age of algorithms. Health Technol (Berl). 2017;7(4):351-367. doi: 10.1007/s12553-017-0179-1. Epub 2017 Mar 16. PMID: 29308344; PMCID: PMC5741783 7(7)

[18] https://www.cbinsights.com/research/ai-startups-fighting-cancer/

[19] A. Mao, "Cancer Signals in Deep Processing," 2018 IEEE 23rd International Conference on Digital Signal Processing (DSP), Shanghai, China, 2018, pp. 1-4, doi: 10.1109/ICDSP.2018.8631704

[20] L. Kaur, M. Sharma, R. Dharwal and A. Bakshi, "Lung Cancer Detection Using CT Scan with Artificial Neural Netwok," 2018 International Conference on Recent Innovations in Electrical, Electronics & Communication Engineering (ICRIEECE), Bhubaneswar, India, 2018, pp. 1624-1629, doi: 10.1109/ICRIEECE44171.2018.9009244.

[21] N. Darapaneni et al., "Early Detection of Skin Cancer - Solution for Identifying and Defining Skin Cancers using AI," 2022 Interdisciplinary Research in Technology and Management (IRTM), Kolkata, India, 2022, pp. 1-6, doi: 10.1109/IRTM54583.2022.9791676.

[22] M. Thachayani and S. Kurian, "AI Based Classification Framework For Cancer Detection Using Brain MRI Images," 2021 International Conference on System, Computation, Automation and Networking (ICSCAN), Puducherry, India, 2021, pp. 1-4, doi: 10.1109/ICSCAN53069.2021.9526456

[23] Brain Tumor Detection and Classification by Hybrid CNN-DWA Model Using MR Images Isselmou Abd El Kader, Guizhi Xu, Zhang Shuai, Sani Saminu Curr Med Imaging, 2021;17(10), 1248-1255

[24] B. Mohammed and B. Nadjia, "Automated assessment of breast density on mammogram images based on convolutional neural networks," 2021 International Conference on Artificial Intelligence for Cyber Security Systems and Privacy (AI-CSP), El Oued, Algeria, 2021, pp. 1-5, doi: 10.1109/AI-CSP52968.2021.9671172.

[25] K. B. Vaishnavee and K. Amshakala, "An automated MRI brain image segmentation and tumor detection using SOM-clustering and Proximal Support Vector Machine classifier," 2015 IEEE International Conference on Engineering and Technology (ICETECH), Coimbatore, India, 2015, pp. 1-6, doi: 10.1109/ICETECH.2015.7275030.

[26] P. Banasode et al “A Melanoma Skin Cancer Detection Using Machine Learning Technique: Support Vector Machine”, IOP Conference Series: Materials Science and Engineering, Volume 1065, 1st International Conference on Frontiers in Engineering Science and Technology (ICFEST 2020) December 18th-19th 2020, Mangalore, India
[27] Shadan Alam Shadab et al “Detection of cancer from histopathology medical image data using ML with CNN ResNet-50 architecture”, In book :Computational Intelligence in Healthcare Applications,2022, Pages 237-254
[28] Md. A. Talukder et. Al. “Machine learning-based lung and colon cancer detection using deep feature extraction and ensemble learning” arXiv:2206.01088v1, 2022
[29] S. Patil, D. Kirange, Ensemble of Deep Learning Models for Brain Tumor Detection, Procedia Computer Science, Volume 218, 2023, Pages 2468-2479, ISSN 1877-0509, https://doi.org/10.1016/j.procs.2023.01.222
[30] Madhusudan G Lanjewar, Kamini G Panchbhai, Panem Charanarur,
[31] Lung cancer detection from CT scans using modified DenseNet with feature selection methods and ML classifiers, Expert Systems with Applications, Volume 224, 2023, 119961, ISSN 0957-4174, https://doi.org/10.1016/j.eswa.2023.119961
[32] https://www.kaggle.com/datasets?search=cancer
[33] https://archive.ics.uci.edu/ml/datasets/
[34] Michael E, Ma H, Li H, Kulwa F, Li J. Breast Cancer Segmentation Methods: Current Status and Future
[35] Potentials. Biomed Res Int. 2021 Jul 20;2021:9962109. doi: 10.1155/2021/9962109. PMID: 34337066; PMCID: PMC8321730
[36] Meselhy Eltoukhy M, Faye I, Belhaouari Samir B. A statistical based feature extraction method for breast cancer diagnosis in digital mammogram using multiresolution representation. Comput Biol Med. 2012 Jan;42(1):123-8. doi: 10.1016/j.compbiomed.2011.10.016. Epub 2011 Nov 23. PMID: 22115076.