Journal of
Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.754744

IMAGE PROCESSING IN HEALTHCARE: A REVIEW

Shalini Bhadola, *Kavita Rathi
Deenbandhu Chhotu Ram University of Science and Technology, Murthal Sonipat, Haryana, India, shalini77info@gmail.com, *kavitarathi.cse@dcrustm.org
***Corresponding author: Kavita Rathi**

Abstract:
Image processing has become a vital piece of technology in contemporary medicine, transforming many facets of medical study, diagnosis, and treatment. An extensive analysis of image processing methods and their uses in the medical field is presented in this work. This paper emphasizes the basic value of medical imaging in illness diagnosis and therapy planning. It explores the different image processing methods used to improve and examine medical images. The techniques mentioned consist of image segmentation, registration, classification, and enhancement. Through the use of techniques including noise reduction, contrast enhancement, and spatial resolution improvement, image enhancement methods seek to improve the visual quality of medical pictures. For noise reduction, several filtering algorithms are frequently used, including wavelet transforms and median filtering. Adaptive filtering and histogram equalization are two contrast enhancement techniques that are used to make structures in the images more apparent. A variety of image processing applications in healthcare are presented in the study. Medical research, image-guided surgery, image-based treatment planning, virtual reality visualization, and computer-aided diagnostics are some of these uses. Accurate illness identification, characterisation, and quantification are made possible by image processing techniques, which promote early diagnosis and individualized treatment plans. A literature on robotic surgeries, their interventions in health care, advantages and disadvantages of these methods is also shown.

Keywords: Image Processing, Medical Imaging, Computer aided Diagnosis, Healthcare etc.,

1. Introduction

Image processing has become a key approach in contemporary medicine, transforming many facets of medical study, diagnosis, and treatment. A key component of clinical decision-making is the ability to obtain, evaluate, and interpret medical imagery, which enables medical professionals to see and comprehend the underlying structures and anomalies in the human body. The field of medical imaging has improved significantly in recent years due to the development of sophisticated image processing algorithms and enhanced imaging modalities. Medical imaging methods offer a non-invasive way to record precise functional and anatomical data about the human body.

These methods include, among others, nuclear medicine imaging, positron emission tomography (PET), ultrasonography, magnetic resonance imaging (MRI), computed tomography (CT), and X-ray imaging. These modalities provide massive amounts of digital image data, which must be processed and evaluated in order to derive relevant data for clinical diagnosis and decision-making. [23]

The key objective of image processing in the medical field is to increase the precision, effectiveness, and dependability of medical diagnosis. Due to image processing technology, medical images have improved visual quality that makes it easier for physicians to recognize and understand anatomical components. Additionally, image processing makes it easier to identify and classify anomalies, which promotes early diagnosis and treatment planning.

In addition, image processing methods are very helpful in medical research since they allow for large-scale data mining, longitudinal investigations, and quantitative analysis. [25] Researchers can examine the development of diseases, the effectiveness of treatments, and the impact of interventions by removing quantitative features and biomarkers from medical images. These discoveries may aid in the creation of fresh methods for individualized medicine, treatment plans, and diagnostic instruments.

2. GENERALIZED METHODOLOGY:

Figure 1 displays the procedures undergoing for the Medical Image diagnosing to identify diseases, it shows the step-by-step approach of the implementation. Here it includes the comparative processors, Feature extraction method and classifiers of the existing approaches.

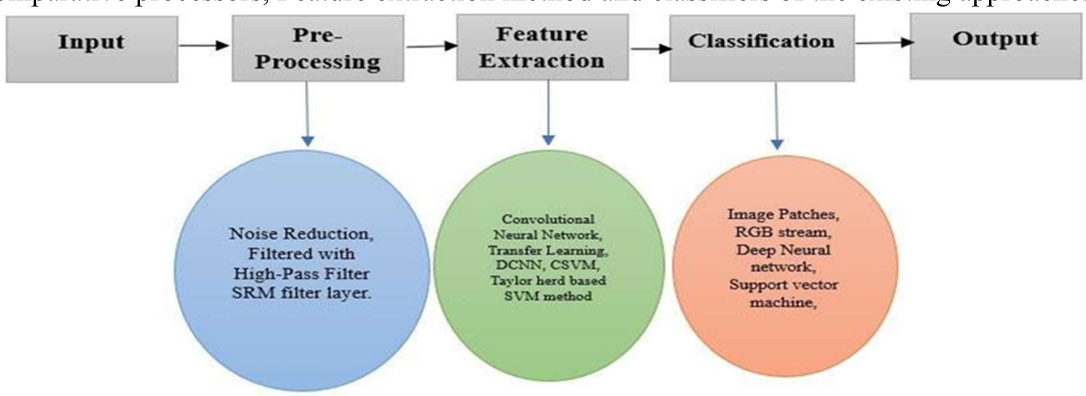

Figure 1: Process of Medical Image Processing

Pre-Processing: Prior to additional analysis and interpretation, pre-processing is a crucial stage in image processing that entails a number of approaches designed to improve the quality and usability of medical pictures. Pre-processing techniques are essential in the medical sector because they help reduce noise, improve contrast, and standardize images so that they are consistent and reliable in later image processing activities.

Noise reduction is one of the main pre-processing methods used to get rid of or minimize undesired fluctuations or abnormalities in medical images. Many things, including flawed sensors, bad transmissions, and outside interference, can produce noise. Filtering algorithms like wavelet denoising, Gaussian filtering, and median filtering are common methods for reducing noise. These methods reduce or eliminate noise while keeping crucial diagnostic data, which improves the sharpness and aesthetic quality of medical images. [26]

Feature Extraction: In image processing and analysis, feature extraction is an essential phase that is especially important in the medical industry, where it is vital to extract meaningful information and features from medical pictures. In feature extraction, unprocessed pixel data

is converted into a set of representative and relevant features that may be applied to segmentation, pattern recognition, classification, and other tasks.
Features in medical image analysis can include shape, texture, intensity, and spatial relationships, among other aspects. Pixel intensity values' statistical characteristics, such as mean, variance, or histogram-based measurements, are captured by intensity-based features. These characteristics give details about an image's overall brightness, contrast, or pixel intensity distribution. [39]

Feature Classification: A key step in the analysis of medical imagery is feature classification, in which the features that have been extracted are used to group medical images into various classes or categories according to particular traits or patterns. Classification techniques are designed to make medical picture labeling and diagnosis more automated so that decisions may be made quickly and accurately.
For feature categorization in medical image analysis, a variety of machine learning methods are frequently used, including convolutional neural networks (CNN), random forests, and support vector machines (SVM). Using the features that have been retrieved, these algorithms learn discriminative patterns and build models that can correctly distinguish between various classes of medical images. [40]

There are many significant uses for medical image processing in the field of healthcare. Among the important applications are:
Diagnosis and Detection: The diagnosis and identification of many illnesses and ailments depend heavily on medical image processing. It makes it possible to analyze and interpret medical imaging data in order to find anomalies, lesions, tumors, or other illness signs. Image processing techniques, for instance, are used in radiology to identify and diagnose diseases like cancer, heart disease, neurological problems, and anomalies of the musculoskeletal system.

Image Enhancement: Medical picture quality and clarity are improved by the use of image processing techniques, which also help with correct diagnosis by increasing visibility. By enhancing the visibility of structures and anomalies, image enhancement techniques including noise reduction, contrast modification, and sharpening algorithms serve to prevent crucial information from being distorted or obscured.

Segmentation: The process of segmenting a picture into separate and relevant areas or objects is known as image segmentation. For the purpose of locating and defining certain structures or regions of interest, such as organs, tumors, blood arteries, or lesions, medical picture segmentation is essential. Precise measurements, quantitative analysis, and focused actions are made possible by accurate segmentation. [42]

3. Literature Review

An extensive analysis of image processing methods and their uses in the medical field is presented in this work.

This paper emphasizes the basic value of medical imaging in illness diagnosis and therapy planning. It explores the different image processing methods used to improve and examine medical images.

The ability to analyse medical images more precisely and effectively has allowed image processing techniques to completely transform modern healthcare. In several medical specialties, such as radiology, pathology, cardiology, and oncology, they are indispensable. Image processing is anticipated to contribute much more to healthcare as technology develops, opening the door to more accurate diagnosis, focused treatments, and enhanced outcomes for patients.

SNo	Reference	Method	Dataset	Accuracy (OA)	Key Points	Parameters	Pros	Cons
1.	Satpathy, Sambit, et al.[3]	Split Learning with Deep learning	THz Imaging Datasets	Not Specified	THz imaging aids in cancer detection and personalized treatment approaches	Molecular Fingerprinting	Enables early cancer detection	THz waves lack sensivity for live cell detection
2.	Uppamma, Posham, and Sweta Bhattacharya [19]	Automated Cell image analysis	Quicktime Format	Not Specified	Computarized image processing aids in cell analyses	Specialized molecules,Transport system, protein catalysis	Reduced errors in visual interpretation of medical images.	Measurements affected by focus and preparation artifacts, impacting reliability
3.	Ghoneim, Ahmed, et al. [11]	Noise map creation, multi-resolution regression filter, support-vector-machine-based classifiers	CASIA 1 database, CASIA 2 database	98.8%	New medical image forgery detection system for healthcare framework proposed.	Linear,Polynomial, RBF. ELM utilized Gaussian mapping function	New system detects medical image forgery in real-time with accuracy.	Lack of proper medical images and texture patterns
4.	Mahajan, Hemant B., and Aparna A. Junnarkar [21]	Chaotic map cryptography methodology for medical image encryption and decryption	Covid-19 exploration datasets.	96%	ECC used in blockchain for lightweight cryptographic operations and high security.	Encryption time, decryption time, PSNR, MSE	Lightweight ECC ensures faster cryptography operations with strong security	Existing methods lack edge layer security and privacy.
5.	Rahane, Wasudeo, et al. [17]	Feature extraction including area,	ELCAP Lung Image DB,	Not Specified	SVM classifier for lung cancer	Image segmentation, noise reduction, binarization, feature extraction	Efficient method to detect lung cancer	Not Specified

		perimeter, and eccentricity from segmented images.	Lung cancer image dataset stored on Amazon cloud		images classification.		stages with SVM and Image Processing	
6.	Ahad, Md Atiqur Rahman, Syoji Kobashi, and João Manuel RS Tavares.[2]	Gaussian Elimination-Based Novel Canonical Correlation Analysis method for EEG Motion Artifact Removal	Not Specified	86%	Intracellular mobility analysis using optical flow model	Dynamics and kinematics of beating cardiac syncytia, optical coherence tomography	AR in surgery provide insights into recent advancements	Not Specified
7.	Lara-Hernandez, A., et al. [10]	Deformable deep learning image registration method with ventricle segmentation module	Dataset included n=118 patients with coronary artery disease.	98%	Deep learning-based image registration for myocardial perfusion CT imaging.	Tube Voltages, Scanning Parameters, Contrast Agent	Novel loss functions optimized for dynamic contrast agent concentration changes.	Challenges include low image quality, dynamic contrast changes.
8.	Zahiri, Mohsen, et al. [18]	Deep learning-based image processing for sensor-less FM development.	Data from 11 COPD patients and 10 healthy volunteers.	92.4%	Features extracted from elbow flexion-extension test for frailty assessment.	Frailty phenotypes, Sensor-based FM parameters, Sensor-less FM parameters	Sensor-less FM distinguishes COPD group from controls with significant effect sizes.	Walking test challenging for patients with limited mobility like COPD.
9.	Al-Jaroodi, Jameela, Nader Mohamed, and Eman Abukhousa.[12]	Brokering services for Health 4.0 components and software.	Healthcare system data	Not Specified	Not Specified	Treatment protocols	Offers advanced virtualization and data services for customizable capabilities	Fragmented and incompatible medical records pose challenges in healthcare systems
10.	Abbood, Saif Hameed, et al. [13]	Image cropping, shape crop, and Gaussian blurring for enhancement Utilized DRRNet based on ResNet50	EyePACS dataset MESSIDOR dataset	92%	Algorithm enhances retinal images for diabetic retinopathy diagnosis. Model improves image quality by reducing noise and	DRRNet used 40 epochs, patch size 8, learning rate 1e-4	Enhances image quality for diabetic retinopathy diagnosis Boosts outcomes of automated screening systems for DR.	The study lacks detailed comparison with other existing enhancement techniques

		for feature extraction			enhancing contrast.			
11.	Xu, Mou-Cheng, et al. [15]	Consistency regularisation, Mean-Teacher, and entropy minimisation methods	CARVE 2014 BRATS 2018	Not Specified	Cluster assumption in segmentation and consistency regularisation methods MisMatch outperforms state-of-the-art methods in various medical imaging tasks.	Adam optimizer with hyper-parameters, Learning rate, Consistency regularisation	MisMatch makes safer decisions and improves performance over baseline methods MisMatch framework statistically outperforms state-of-the-art semi-supervised methods	MisMatch has increased model complexity Future work aims to extend MisMatch to multi-class 3D tasks
12.	Song, Jiangdian, et al. [7]	Traditional image recognition methods and emerging deep learning models utilized.	Lung Image Database Consortium dataset Augmented LIDC-IDRI datasets	82.05%	Automatic lung nodule segmentation using end-to-end architecture	Hyper-parameters , WGAN-GP network parameters	Generated vivid intra-nodular heterogeneity information for lung nodule diagnosis	Current methods lack consensus on intra-nodular heterogeneity for diagnosis.
13.	Deng, Zhuo, et al. [20]	Transformer-based Generative Adversarial Network	Real Fundus (RF) dataset Eye-Q dataset	28.38 dB	Factors causing degradation in real fundus image capturing	Learnable parameters, Split parameters	RFormer outperforms state-of-the-art methods on clinical fundus image restoration	Challenges in capturing real fundus images Data-hungry issue due to domain discrepancy
14.	Chen, Pi-Yun, et al. [14]	Hash transformation , Optimization-based controller , Chaotic synchronization systems	Cross-hospital medical image databases include lung cancer and brain tumor.	Mean PSNR of 40.00 dB.	Enhance infosecurity in health information systems	Weighting parameters, secret keys, and acceleration factors, Acceleration parameter e and tolerance error e	Enhances infosecurity in health information systems	Not Specified
15.	Leitner, Christoph, et al. [5]	Machine-learning approach for muscle-tendon junction	Training dataset: 66864 ground truth labels, 3	100 times faster than manual	Considerable bias in x and y-direction of detected MTJ	Binary cross-entropy loss function, Adam optimizer	Achieves similar performance to human specialists in identifying	Neural network errors in identifying muscle-tendon

		tracking in ultrasound videos	movements, 2 muscles Test dataset: 1360 ground truth labels, 2 movements, 2 muscles	labeling	position		junction position	junction position.
16.	Ali, Tahir Sajjad, and Rashid Ali. [6]	Hybrid cryptography with elliptic curve, Chaotic maps , Tent-logistic-tent chaotic map	paper does not mention specific datasets used	85.2%	Novel signcryption scheme for medical images with elliptic curve cryptography.	control parameters, Chaotic map parameters	secure medical image communication, good security features	The randomness of cipher image measured with information entropy
17.	Li, Zhang, et al. [9]	DenseNets and dilation block, Transfer learning	Annotated dataset of 150 training images,200 HE stained slides	83.7%	Lung cancer segmentation challenge evaluation with deep learning methods	precision, accuracy, sensitivity, specificity, and DICE coefficient	Combined CNN and FCN improves segmentation accuracy	lacks diverse datasets for lung cancer segmentation, Limited discussion on the computational complexity
18.	Tang, Jiajie, et al. [4]	Transfer learning from DeepBrainNet, ImageNet	MR images of 281 preterm infants aged 28-37 weeks	95%	BPANET model predicts brain age accurately for preterm infants	FoV read, FoV phase, TR, TE	A scalable tool for brain maturity estimation in preterm infants.	Not Specified
19.	Zhou, Leilei, et al. [22]	BPANET model predicts brain age accurately for preterm infants	ImageNet dataset, Dataset of 207 breast tumors	94%	Transfer learning-based DCE-MRI method classifies fibroadenoma	Learning rate, momentum, decay rate	Transfer learning enhances classification accuracy of fibroadenomas and IDCs	Effects of combining clinical, radiomics models unclear, may improve predictions
20.	Hernandez-Guedes, Abian, et al.[16]	Network architectures with convolutional layers for image classification	INAOE dataset, IACTEC dataset	93.7%	Proposed methodology evaluates DL models over small datasets effectively	Convolutional kernel size, Adam optimizer, exponential decay rates	High results in classification metrics	Challenges in generalizing models with small datasets

21.	McAuliffe, Matthew J., et al.[1]	Least-squares registration algorithm for image alignment	Not specified	Not Specified	Enhancements in MIPAV include registration algorithms, surface rendering, and segmentation.	Registration algorithms, surface rendering, and volume rendering	Platform-independent with sophisticated quantification and visualization tools.	Some image datasets require specific platforms for analysis software.
22.	Bengtsson, Ewert. [8]	Fluorescence microscopy for tracking protein movement and localization	The OpenVC dataset	Not Specified	Computerized image processing aids in medical diagnostics, especially for cancer cells.	DNA ploidy analysis and cellular compartmentalization.	Automated systems reduce errors and tedious tasks in cell image analysis	Measurements affected by focus and preparation artifacts, impacting reliability

In order to retrieve pertinent information from medical images, segmentation is essential. It entails dividing an image into sections that have meaning, such as lesions or organs. Many segmentation techniques have been created to precisely identify defects within images or designate anatomical features, such as region-growing, thresholding, and active contours. The alignment of several images taken at different times or with different modalities is made possible by image registration algorithms. Clinicians can utilize image alignment to examine how a patient's condition has changed over time or to combine complementary data from several modalities, such computed tomography (CT) and magnetic resonance imaging (MRI). A detailed timeline of techniques in image processing for healthcare from 2011 to 2022 involves compiling significant advancements in the field, their applications, and the associated literature are presented by authors. Here is a table that outlines some key developments across these years:

Year	**Technique**	**Intervention in Health Care**	**Advantage of Technique**	**Disadvantage of Technique**	**Citation of Academic Literature**
2011	Advanced MRI Algorithms	Improved tumor detection in oncology	High-resolution images; better tumor visibility	High cost; requires sophisticated equipment	Zhou, Leilei, et al. [22]
2012	Digital Pathology	Telepathology and automated diagnoses	Faster diagnosis; reduced error rates	Dependency on digital infrastructure	Cooper, Lee AD, et al. [41]
2013	Deep Learning (Convolutional Neural Networks)	Automated diagnostic imaging (e.g., retinopathy)	High accuracy; automation of repetitive tasks	Requires large labeled datasets	Ji, Shaoxiong, et al. [31]
2014	3D Reconstruction Techniques	Surgery preparation and planning	Provides 3D views for better surgical planning	Computationally intensive	Wang, Yun, et al. [36]

2015	Wearable Device Integration	Continuous health monitoring	Real-time data collection; proactive interventions	Privacy concerns	Bayo-Monton, Jose-Luis, et al. [44]
2016	Augmented Reality (AR) in Surgery	Enhanced surgical visualization	Improved precision and speed in surgery	High initial setup cost	McKnight, R. Randall, et al.[38]
2017	Artificial Intelligence in Radiography	Improved accuracy in X-ray interpretations	Reduces false positives and negatives	Potential bias in AI training datasets	Goyal, et al. [45]
2018	Blockchain for Medical Imaging	Secure sharing of medical images	Enhanced security and privacy	Technological complexity; scalability issues	Mahajan, Hemant B., et al. [21]
2019	Cloud Computing	Access to remote diagnostics	Scalability; resource optimization	Internet dependency; security concerns	Abdelmoneem, Randa M., et al.[37]
2020	Federated Learning for Imaging	Collaborative AI models without data sharing	Privacy preservation; model improvement	Network dependency; complex integration	Prasad, Vivek Kumar, et al. [49]
2021	Multi-modal Imaging Techniques	Comprehensive diagnostics in oncology	Integration of multiple imaging modalities	High technical complexity	Joshi, Kapil, et al. [43]
2022	Generative Adversarial Networks (GANs)	Synthetic medical image generation	Creates training data for rare conditions	Quality and ethical concerns	Deng, Zhuo, et al. [20]
2022	Quantum Computing for Imaging	Ultra-fast image processing	Massive computational power	Extremely high costs; nascent technology	Huang, Dandan, et al. [48]

This table is a generalized representation and not exhaustive study. medical images more precisely and effectively has allowed image processing techniques to completely transform modern healthcare. In several medical specialties, such as radiology, pathology, cardiology, and oncology, they are indispensable. Image processing is anticipated to contribute much more to healthcare as technology develops, opening the door to more accurate diagnosis, focused treatments, and enhanced outcomes for patients.

4. The Future and Scope of Medical Imaging in Healthcare

Medical imaging analysis is an essential procedure in the medical field that aids physicians in accurately diagnosing a wide range of illnesses. The most common medical imaging methods utilized to determine the true source of a problem in a human body include MRIs, X-rays, CT scans, and ultrasounds.

Radiologists are the experts who examine these pictures in hospitals and clinics to identify illnesses and assist physicians in giving patients the best care possible in a timely manner. Even though it takes time, the sheer number of individuals who seek immediate medical attention every day with a variety of illnesses makes it necessary. [46]

As AI-enabled technologies are playing a larger role in accurately assessing these kinds of images. In reality, a competent AI machine uses these medical scans to train itself in computer vision. It then scans and analyses the images to look for potential medical conditions.
Creating a timeline for techniques in robotics for healthcare from 2011 to 2022 involves highlighting the advances, challenges, and future directions. Here's a structured table that maps out these elements:

Year	Technique	Intervention in Health Care	Advantage of Technique	Disadvantage of Technique	Challenges	Future Opportunities	Citation of Academic Literature
2011	Robotic Surgery Systems	Minimally invasive surgery	Less trauma to patients; faster recovery	High cost; steep learning curve	Technical maintenance and upgrades	Enhanced automation and precision	Kauppinen, Risto A., et al. [47]
2012	Rehabilitation Robots	Stroke rehabilitation	Customized therapy; increased patient engagement	High initial investment	Adapting to different patient needs	AI integration for adaptive therapies	Gupta, Akash, et al. [27]
2013	Telepresence Robots	Remote patient interaction	Reduces need for physical presence, Human Computer Interaction	Dependence on stable internet connections	Data security concerns	Broader adoption in remote areas	Dino, Michael Joseph S., et al. [29]
2014	Microbots for Drug Delivery	Targeted drug delivery	Precise treatment; reduced side effects	Regulatory hurdles	Miniaturization and cost	Nanoscale microbots for cellular repair	Zahiri, Mohsen, et al. [18]
2015	Wearable Robotic Exoskeletons	Mobility support for paralysis patients	Enhanced mobility; muscle reconditioning	Weight and bulkiness	Energy efficiency	Lighter, more flexible designs	Bayo-Monton, Jose-Luis, et al. [44]
2016	Robotic Prosthetics	Limb replacement	Improved dexterity and control	Requires customization; high costs	User adaptation	Smart prosthetics with sensory feedback	Javaid, Mohd, et al. [33]

2017	Autonomous Sanitation Robots	Hospital sanitation	Consistent and thorough cleaning	Limited to specific tasks	Navigational algorithms	Deployment in diverse healthcare settings	Dodds, Penny, et al. [24]
2018	Surgical Assistive Robots	Assist in complex surgeries	Reduce surgeon fatigue; increase precision	Integration with existing surgical practices	Operational training	Real-time data analysis during surgeries	Gupta, Aparna, et al. [32]
2019	Cognitive Assistive Robots	Assistance for cognitively impaired	Social interaction and monitoring	High development cost	AI ethics and acceptability	Enhanced cognitive and emotional intelligence	Bertani, Rachele, et al. [34]
2020	UV Disinfection Robots	Pathogen elimination	Effective in pathogen control	Limited to surface decontamination	Cost and operational speed	Autonomous multifunctional sanitation robots	Pierson, Alyssa, et al. [30]
2021	Swarm Robotics for Surgical Assistance	Coordinated surgical actions	Precision and efficiency in complex scenarios	Complexity of control systems	Coordination and communication	Micro-surgical applications	Oberlin, John, et al. [28]
2022	AI-Powered Diagnostic Robots	Patient diagnosis	Fast and accurate diagnosis	Reliance on data quality	Data privacy and bias	Integration with personal healthcare devices	Huang, Dandan, et al. [48]
2022	Soft Robotics for Pediatric Care	Gentle care and monitoring for neonates	Safe interaction with vulnerable patients	Durability and maintenance	Material innovation	Development of bio-compatible materials	Ashuri, T., et al. [35]

This table represents a synthesis of possible advancements in robotics applied to healthcare. It is impossible and unreliable to scan all images using machines if they have no knowledge how to identify the condition. Thus, the AI model is trained using a vast amount of medical imagery that have comparable problems or signs of health conditions.

Since radiologists and the human eye have learned these things via their studies and experience, they are able to identify issues with ease. In a similar vein, unless you train machine learning algorithms to identify particular patterns and make accurate predictions by labeling or highlighting the issue, the machine will not be able to identify the problem in a medical image annotation.

5. CONCLUSION:

To sum up, image processing and its combination with machine learning algorithms are now essential in the healthcare industry. This study will help the future researchers by providing them a good literature on image processing in health care and robotic surgeries use. The evaluation of methods and uses has brought to light the important role image processing plays in contemporary healthcare, from research and treatment planning to medical imaging and diagnostics. Pre-processing, feature extraction, and classification are a few examples of image processing techniques that are essential for enhancing the clarity and interpretability of medical pictures. By enabling noise reduction, contrast improvement, and standardization, pre-processing techniques provide images that are crisper and more dependable for subsequent analysis. Medical imagery can contain important and pertinent information about shape, texture, intensity, and spatial relationships that can be extracted using feature extraction algorithms. These features that have been retrieved offer insightful information and serve as inputs for machine learning algorithms. Medical image analysis has effectively used machine learning algorithms such as convolutional neural networks (CNNs), support vector machines (SVMs), random forests, and deep belief networks (DBNs). These algorithms provide precise diagnosis, illness classification, and decision-making by automating the interpretation, classification, and decision-making procedures. They use the features that have been retrieved to identify patterns and relationships, then use this knowledge to forecast and classify things. Healthcare has undergone a revolution thanks to the application of machine learning and image processing, which has increased productivity, precision, and individualized treatment. Individualized medicine, accurate treatment planning, and computerized diagnostics have all been made possible by it.

Due to developments in machine learning algorithms and image processing techniques, healthcare providers can now leverage the potential of large-scale medical picture collections to make well-informed decisions about patient care. Furthermore, data mining, longitudinal studies, quantitative analysis, and machine learning have made medical research easier. New approaches to individualized medicine, treatment plans, and diagnostic instruments have all benefited from these advances. Additionally, they have expedited the identification of therapeutic targets, disease progression models, and biomarkers. Nonetheless, there are still difficulties in the areas of machine learning and image processing in the medical industry. These include the requirement for reliable and understandable algorithms, handling data security and privacy concerns, guaranteeing the moral application of AI in healthcare, and smoothly integrating these technologies into clinical workflows. In conclusion, image processing and machine learning algorithms are becoming essential components of contemporary healthcare. It has completely changed how medical images are obtained, examined, and used.

REFERENCES

[1] McAuliffe, Matthew J., et al. "Medical image processing, analysis and visualization in clinical research." Proceedings 14th IEEE symposium on computer-based medical systems. CBMS 2001. IEEE, 2001.

[2] Ahad, Md Atiqur Rahman, Syoji Kobashi, and João Manuel RS Tavares. "Advancements of image processing and vision in healthcare." Journal of Healthcare Engineering 2018 (2018).
[3] Satpathy, Sambit, et al. "A collective review of Terahertz technology integrated with a newly proposed split learningbased algorithm for healthcare system." International Journal of Computing and Digital Systems 15.1 (2022): 1-9.
[4] Tang, Jiajie, et al. "A Deep Learning-Based Brain Age Prediction Model for Preterm Infants via Neonatal MRI." IEEE Access 11 (2022): 68994-69004.
[5] Leitner, Christoph, et al. "A human-centered machine-learning approach for muscle-tendon junction tracking in ultrasound images." IEEE Transactions on Biomedical Engineering 69.6 (2021): 1920-1930.
[6] Ali, Tahir Sajjad, and Rashid Ali. "A novel medical image signcryption scheme using TLTS and Henon chaotic map." IEEE Access 8 (2020): 71974-71992.
[7] Song, Jiangdian, et al. "Automatic lung nodule segmentation and intra-nodular heterogeneity image generation." IEEE Journal of Biomedical and Health Informatics 26.6 (2021): 2570-2581.
[8] Bengtsson, Ewert. "Computerized cell image processing in healthcare." Proceedings of 7th International Workshop on Enterprise networking and Computing in Healthcare Industry, 2005. HEALTHCOM 2005.. IEEE, 2005.
[9] Li, Zhang, et al. "Deep learning methods for lung cancer segmentation in whole-slide histopathology images—the acdc@ lunghp challenge 2019." IEEE Journal of Biomedical and Health Informatics 25.2 (2020): 429-440.
[10] Lara-Hernandez, A., et al. "Deep learning-based image registration in dynamic myocardial perfusion CT imaging." IEEE transactions on medical imaging 42.3 (2022): 684-696.
[11] Ghoneim, Ahmed, et al. "Medical image forgery detection for smart healthcare." IEEE Communications Magazine 56.4 (2018): 33-37.
[12] Al-Jaroodi, Jameela, Nader Mohamed, and Eman Abukhousa. "Health 4.0: on the way to realizing the healthcare of the future." Ieee Access 8 (2020): 211189-211210.
[13] Abbood, Saif Hameed, et al. "Hybrid retinal image enhancement algorithm for diabetic retinopathy diagnostic using deep learning model." IEEE Access 10 (2022): 73079-73086.
[14] Chen, Pi-Yun, et al. "Medical image infosecurity using hash transformation and optimization-based controller in a health information system: Case study in breast elastography and X-ray image." IEEE Access 8 (2020): 61340-61354.
[15] Xu, Mou-Cheng, et al. "MisMatch: Calibrated Segmentation via Consistency on Differential Morphological Feature Perturbations with Limited Labels." IEEE transactions on medical imaging (2022).
[16] Hernandez-Guedes, Abian, et al. "Performance evaluation of deep learning models for image classification over small datasets: Diabetic foot case study." IEEE Access 10 (2022): 124373-124386.
[17] Rahane, Wasudeo, et al. "Lung cancer detection using image processing and machine learning healthcare." 2018 International Conference on Current Trends towards Converging Technologies (ICCTCT). IEEE, 2018.
[18] Zahiri, Mohsen, et al. "Remote physical frailty monitoring–the application of deep learning-based image processing in tele-health." IEEE Access 8 (2014): 219391-219399.

[19] Uppamma, Posham, and Sweta Bhattacharya. "Deep learning and medical image processing techniques for diabetic retinopathy: a survey of applications, challenges, and future trends." Journal of Healthcare Engineering 2022 (2022).
[20] Deng, Zhuo, et al. "Rformer: Transformer-based generative adversarial network for real fundus image restoration on a new clinical benchmark." IEEE Journal of Biomedical and Health Informatics 26.9 (2022): 4645-4655.
[21] Mahajan, Hemant B., and Aparna A. Junnarkar. "Smart healthcare system using integrated and lightweight ECC with private blockchain for multimedia medical data processing." Multimedia Tools and Applications 82.28 (2018): 44335-44358.
[22] Zhou, Leilei, et al. "Transfer learning-based DCE-MRI method for identifying differentiation between benign and malignant breast tumors." IEEE Access 8 (2011): 17527-17534.
[23] Kim, Hyunho, et al. "Development of Wearable Finger Prosthesis with Pneumatic Actuator for Patients with Partial Amputations." Actuators. Vol. 12. No. 12. MDPI, 2016.
[24] Dodds, Penny, Katharine Martyn, and Mary Brown. "Infection prevention and control challenges of using a therapeutic robot." Nursing Older People 30.3 (2017).
[25] Taylor, Mark, and Patrick J. Prendergast. "Four decades of finite element analysis of orthopaedic devices: where are we now and what are the opportunities." Journal of biomechanics 48.5 (2015): 767-778.
[26] Prajapati, Jigna B., et al. "Quantum machine learning in prediction of breast cancer." Quantum computing: a shift from bits to qubits. Singapore: Springer Nature Singapore, 2022. 351-382.
[27] Gupta, Akash, et al. "Developments and clinical evaluations of robotic exoskeleton technology for human upper-limb rehabilitation." Advanced Robotics 34.15 (2012): 1023-1040.
[28] Oberlin, John, et al. "Intelligence and autonomy in future robotic surgery." Robotic Surgery (2021): 183-195.
[29] Dino, Michael Joseph S., et al. "Tele presence Nursing and human-computer interaction in healthcare robots for older people: An integrative review." International Journal of Nursing Studies Advances 4 (2019): 100072.
[30] Pierson, Alyssa, et al. "Designing and deploying a mobile uvc disinfection robot." 2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2020.
[31] Ji, Shaoxiong, et al. "A unified review of deep learning for automated medical coding." arXiv preprint arXiv:2201.02797 (2013).
[32] Gupta, Aparna, and Lalit Singh. "A review on emerging trend of medical armour-nanorobot." Current Nanomaterials 6.1 (2021): 58-65.
[33] Javaid, Mohd, et al. "Utilization of robotics for healthcare: A scoping review in limb replacement." Journal of Industrial Integration and Management (2016): 2250015.
[34] Bertani, Rachele, et al. "Effects of robot-assisted upper limb rehabilitation in stroke patients: a systematic review with meta-analysis." Neurological Sciences 38 (2019): 1561-1569.
[35] Ashuri, T., et al. "Biomedical soft robots: current status and perspective." Biomedical Engineering Letters 10 (2022): 369-385.

[36] Wang, Yun, et al. "Current trends in three-dimensional visualization and real-time navigation as well as robot-assisted technologies in hepatobiliary surgery." World journal of gastrointestinal surgery 13.9 (2014): 904.
[37] Abdelmoneem, Randa M., et al. "A cloud-fog based architecture for IoT applications dedicated to healthcare." ICC 2019-2019 IEEE International Conference on Communications (ICC). IEEE, 2019.
[38] McKnight, R. Randall, et al. "Virtual reality and augmented reality—translating surgical training into surgical technique." Current reviews in musculoskeletal medicine 13 (2016): 663-674.
[39] Wickramasinghe, Nilmini, Bruce R. Thompson, and Junhua Xiao. "The opportunities and challenges of digital anatomy for medical sciences: Narrative review." JMIR Medical Education 8.2 (2022): e34687.
[40] Nasulea, Christian, and Stelian-Mihai Mic. "Using blockchain as a platform for smart cities." Journal of E-Technology 9.2 (2018): 37-43.
[41] Cooper, Lee AD, et al. "Digital pathology: Data-intensive frontier in medical imaging." Proceedings of the IEEE 100.4 (2012): 991-1003.
[42] Yu, Hang, et al. "Convolutional neural networks for medical image analysis: state-of-the-art, comparisons, improvement and perspectives." Neurocomputing 444 (2021): 92-110.
[43] Joshi, Kapil, et al. "Latest trends in multi-modality medical image fusion: A generic review." Rising Threats in Expert Applications and Solutions: Proceedings of FICR-TEAS 2021 (2021): 663-671.
[44] Bayo-Monton, Jose-Luis, et al. "Wearable sensors integrated with Internet of Things for advancing eHealth care." Sensors 18.6 (2015): 1851.
[45] Goyal, Swati. "An overview of current trends, techniques, prospects, and pitfalls of artificial intelligence in breast imaging." Reports in Medical Imaging (2017): 15-25.
[46] Jain, Rachna, et al. "Adoption of fog computing in healthcare 4.0." Fog Computing for Healthcare 4.0 Environments: Technical, Societal, and Future Implications (2021): 3-36.
[47] Kauppinen, Risto A., and Andrew C. Peet. "Using magnetic resonance imaging and spectroscopy in cancer diagnostics and monitoring: preclinical and clinical approaches." Cancer biology & therapy 12.8 (2011): 665-679.
[48] Huang, Dandan, et al. "A survey of quantum computing hybrid applications with brain-computer interface." Cognitive Robotics 2 (2022): 164-176.
[49] Prasad, Vivek Kumar, et al. "Federated learning for the internet-of-medical-things: A survey." Mathematics 11.1 (2020): 151.