CHAPTER 2
LITERATURE REVIEW

Brain tumor detection and classification is a critical area of medical imaging that involves the use of advanced imaging techniques and machine learning algorithms to analyze brain scans and identify the presence of tumors. Brain tumors are abnormal growths of cells within the brain or surrounding tissues, and can be Benign (non-cancerous) or Malignant (cancerous). Pre-processing, Segmentation, Feature Extraction and Feature Classsification are stages performed for detection and classification of Brain Tumor. This chapter aims literature survey on above stages. For the Image Acquisition or Image modalities stage, suvery of the different modalities; like, MRI, CT scan, PET etc. For Pre-processing of the MRI Brain Images, suvery of the different filters; like, wiener filter, anisotropic filter, median filter, non local means filter, combined filters, etc. was described. For Segmentation of the MRI image, survey of the different multithresholding algorithm of the MRI images was described. For Feature extraction of the Brain MRI Images, survey of different Feature Extraction methods; like, DWT, GLCM, LBP, etc. was described. In For Feature Classification of the MRI Images,suvey of different classification methods; like, SVM, CNN, etc. was described.

2.1 PROCESS OF THE BRAIN TUMOR DETECTION AND CLASSIFICATION

Figure 2.1 shows the general block diagram of the Image detection and classification. It consists of the following main stages :

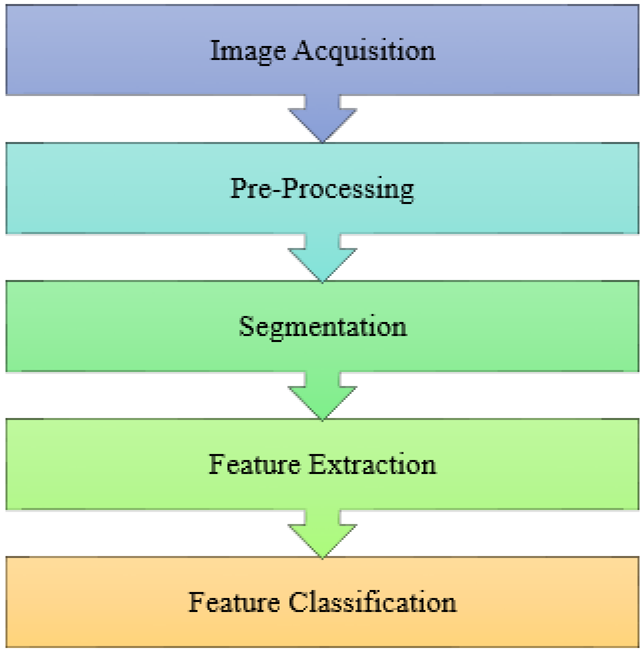

Figure 2.1 General Block Diagram of the Image Detection and Classification[6]

In Image Acquisition, from where taken the images, this involves acquiring a digital image of the brain using imaging techniques such as Magnetic Resonance Imaging, Computed Tomography or Positron Emission Tomography. First stage is Pre-Processing of the image, in this stage the acquired image may contain noise, artifacts, and other unwanted elements that can affect the accuracy of the analysis. This stage involves processing the image to remove these unwanted elements and enhance the quality of the image. Second stage is Segmentation of the image, in this stage, the image is partitioned into smaller regions or segments that correspond to different tissues or structures in the brain. This can be done using various techniques such as thresholding, region growing, or clustering. Third stage is Feature Extration of the image, in this stage extract relevant features or characteristics from each segment. These features may include texture, shape, intensity, and statistical properties of the segmented regions. Fourth stage is Feature Classification of the image, in this stage the extracted features are fed into a classifier, which is trained to distinguish between different types of brain tumors. The classifier may be based on machine learning algorithms such as Support Vector Machines, Artificial Neural Networks or Random Forests.

It involves acquiring the image, preprocessing it to enhance its quality, segmenting it to identify different regions, extracting features from these regions, and finally classifying the tumor based on the extracted features.

2.2 IMAGE ACQUISITION

A modality is device or system that generates images of the internals of the human body. Examples of specific modalities include computed tomography scanners and nuclear medicine (nm) cameras. In addition to images, some modalities can also create other evidence objects such as grayscale softcopy presentation states for the consistent viewing of images or evidence documents containing measurements. Modalities are typically not included as part of the PACS, mainly because they are already existing, independently of a PACS. An exception to this is Computerized and Digital Radiography. The reason to include CR/DR modalities as part of Picture Archiving And Communication System, is that their benefits are really only realized when using a PACS to archive, view and communicate the images.

Brain imaging involves the use of various image modalities to visualize the structure, function, and metabolism of the brain. Magnetic Resonance Imaging is a non-invasive imaging modality that uses a magnetic field and radio waves to produce high-resolution images of the brain's anatomy. Functional Magnetic Resonance Imaging measures changes in blood flow in the brain to study brain function and connectivity. Positron Emission Tomography imaging uses a small amount of radioactive material to produce images of the brain's metabolic activity. These image modalities are valuable tools for diagnosis and research in a variety of neurological and psychiatric conditions. With modern technology in the medical field, doctors are able to diagnose and treat patients without any dangerous side effects. Medical imaging is considered to be one of the best means to achieve that aim, being able to observe what’s happening inside the body without the requirement for surgery or other invasive measures. Medical imaging can be defined as a technique of developing visual representations of areas inside the human body to diagnose health issues and accordingly monitor treatment.

The procedure has had a great impact on public health. Being one of the most powerful resources available for the patients, medical imaging can be used for both therapeutic and diagnostic purposes.

2.2.1 IMAGE MODALITIES

There are different types of the Image Modalities; like; Magnetic Resonance Imaging, Ultrasonic, Radiography, Computer Tomography etc. MRI involves magnetic fields and radio waves to look at the organs and other structures in the human body. The process needs an MRI scanner, which is a huge tube that contains a massive circular magnet. This magnet creates a magnetic field that aligns the protons of hydrogen atoms in the body. The protons are then exposed to radio waves, causing the protons to rotate. When the radio waves are turned off, the protons relax and realign themselves, emitting radio waves in the recovery process that can be sensed by the machine to develop an image.Ultrasound Imaging procedure makes use of high-frequency sound waves, that is reflected off tissue to develop images of joints, muscles, organs, and soft tissues. It's like shining light on the inside of the body, except that the light travels through the skin layers and can only be viewed using electronic sensors. Being one of the most cost-effective forms of medical imaging, Ultrasound has no harmful effects and is also regarded as the safest form of medical imaging with a wide range of applications. Radiography imaging procedure uses electromagnetic radiation to take images of the inside of the body. The most popular and common form of radiography is x-ray. For this imaging procedure, an x-ray machine beams high-energy waves onto the body. The soft tissues, like organs and skin, do not absorb these waves, whereas hard tissues like bones do absorb such waves. The machine transfers the x-ray results onto a film, indicating the body parts that absorbed the waves in white and leaving the unabsorbed material in black. In CT imaging**,** a form of X-ray that develops 3 dimensional pictures for diagnosis. Also known as Computed Axial Tomography, it uses X-rays to develop cross-sectional images of the human body. The scanner has a huge circular opening for the patient to lie on a motorized table. The detector and X-ray then rotate around the patient developing a narrow 'fan-shaped' beam of x-rays that passes through a section of the patient's body to develop an image. CT scans offer greater clarity than conventional x-rays with more precise images of the bones, blood vessels, internal organs, and soft tissue within the body. In most cases, the use of CT scans prevents the requirement for exploratory surgery. Survery of the different modalities are as follows:

ASSAS Ouarda, et.al (2023) conducted study on "Fuzzy Segmentation of MR Brain Real Images Using Modalities Fusion" This work aims to improve brain MRI segmentation by fusing information from different modalities using Fuzzy C-Means approach. With the availability of more data from different sources, multi-modality image fusion seeks to obtain more inferences than a single modality can provide. The adopted fusion approaches were compared using four criteria, and the experimental results on real MR brain images showed that the fusion approaches were more accurate and robust than the standard FCM approach[1]

Guoyang xie,et.al (2022) presented study on “Cross-Modality Neuroimage Synthesis: A Survey” Multi-modality imaging can improve disease diagnosis and reveal distinct deviations in tissues, but collecting fully-aligned and paired data is expensive and impractical. Cross-modality synthesis using unsupervised or weakly-supervised learning methods can be an alternative solution to synthesize absent neuroimaging data. This paper provides a comprehensive review of cross-modality synthesis for neuroimages, including weakly-supervised and unsupervised settings, loss functions, evaluation metrics, ranges of modality, datasets, and synthesis-based downstream applications. The paper also highlights the opening challenges for cross-modality neuroimage synthesis[7]

Javaria Amin et.al (2022) presented study on “Brain tumor detection and classification using machine learning: a comprehensive survey” Brain tumor detection remains a challenging task due to variations in tumor location, shape, and size. This survey aims to provide a comprehensive literature review on brain tumor detection through magnetic resonance imaging. The survey covers the anatomy of brain tumors, publicly available datasets, enhancement techniques, segmentation, feature extraction, classification, and deep learning, transfer learning, and quantum machine learning for brain tumor analysis. It also provides important literature for the detection of brain tumors with their advantages, limitations, developments, and future trends to help researchers in this field[8]

Ananth Shankar et.al (2020) study focused on “Hybrid PET–MRI Imaging in Paediatric and TYA Brain Tumours: Clinical Applications and Challenges” The gold standard for brain tumour imaging in paediatric and teenage and young adult patients is the standard magnetic resonance imaging (MRI). combining positron emission tomography with MRI can improve diagnostic accuracy. A study was conducted using 18F-fluorocholine (FCho) and 18fluoro-L-phenylalanine (FDOPA) PET–MRI in paediatric/TYA neuro-oncology patients, and the results showed that hybrid PET–MRI has potential in evaluating gliomas and germ cell tumours for assessing early treatment response and discriminating tumour from treatment-related changes. the combined

PET–MRI approach shows promise for improved diagnostic and therapeutic assessment in paediatric and TYA brain tumours[31].

Vijay Sawlani et.al (2020) presented study on "Multiparametric MRI: practical approach and pictorial review of a useful tool in the evaluation of brain tumours and tumour like lesions" MRI plays a crucial role in evaluating intracranial lesions, but conventional MRI has limited specificity. The use of multiparametric MRI, including diffusion-weighted imaging, perfusion-weighted imaging, and magnetic resonance spectroscopy, allows for more accurate assessment of the tissue microenvironment. This educational pictorial review aims to demonstrate how multiparametric MRI can aid in diagnosis, treatment planning, and assessment of treatment response. The review also provides a practical approach for performing and interpreting multiparametric MRI in the clinical setting. The presented cases illustrate how multiparametric MRI can differentiate neoplastic from non-neoplastic lesions more accurately than conventional MRI alone[32]

Prabhjot Kaur Chahal et.al (2019) conducted study on "A survey on brain tumor detection techniques for MR images" Detecting abnormal tissues from normal brain tissues is a crucial task in brain tumor detection. Medical image processing, particularly on MR images, has been effectively used to automate the core steps of extraction, segmentation, and classification for tumor detection. computer-aided diagnosis or detection systems remain a challenge due to the variability in tumor shapes, areas, and sizes. In Paper various brain tumor detection techniques for MR images are reviewed, along with their strengths and difficulties encountered. The current segmentation, classification, and detection techniques are also discussed, emphasizing the pros and cons of each approach. The survey aims to help researchers derive essential characteristics of brain tumor types and identify successful segmentation/classification techniques for detecting a range of brain diseases. The manuscript covers the most relevant strategies, methods, their working rules, preferences, constraints, and future challenges in MR image brain tumor detection[33].

ASSAS Ouarda, et.al (2016) presented study on "MR Brain Real Images Segmentation Based Modalities Fusion and Estimation Et Maximization Approach" Multi-modality image fusion combines information from different images to obtain more inferences than can be derived from a single modality. This paper aims to improve the segmentation of cerebral IRM real images by fusing modalities (T1, T2) using the Estimation et Maximization approach. The paper evaluates the adopted approaches using four criteria, including standard deviation, entropy of information, coefficient of correlation, and space frequency. The experimental results on MRI brain real images show that the adopted fusion approaches are more accurate and robust than the standard EM approach[88].

Vedran Omeragic, et.al (2013) presented study on "Data Acquisition Modalities" The paper discusses the revolutionary changes and significant advancements in medical imaging techniques due to the development in technology over the past few decades. Every medical imaging modality has a mathematical model and algorithms to reconstruct images from the measured data. The paper focuses on introducing data acquisition in these techniques, including their process, advantages, limitations, and short history[100].

Umesh B. Mantale, et.al (2013) study focused on "Image Fusion of Brain Images using Redundant Discrete Wavelet Transform" Medical images from different modalities carry different information, making it difficult to produce a single image from all of them. Image fusion using various processing algorithms has become an essential tool for producing good quality images or image streams. This paper proposes a Redundant Discrete Wavelet Transform based algorithm for image fusion in medical imaging, specifically for brain atlas-based images. The proposed method is compared with other DWT based methods based on statistical measures such as entropy, mean, and standard deviation. The assessment shows that the proposed method produces better results[101].

2.3 PRE-PROCESSING OF THE BRAIN MRI IMAGE

Pre-processing noise removal in brain tumor detection and classification refers to the application of various techniques to reduce noise in the medical images, which can interfere with the accurate detection and classification of brain tumors. The pre-processing noise removal step is important because medical images often contain a significant amount of noise that can make it difficult to identify the tumor and distinguish it from surrounding healthy tissue.

2.3.1 NOISE MODELS

Following the literature survey conducted in previous research for different noise affected to an image:

Tulasi Gayatri Devi, et.al (2023) conducted study on "Analysis & Evaluation of Image Filtering Noise reduction technique for Microscopic Images" This paper discusses the use of advanced digital image processing techniques in the field of microscopy for accurate cell classification. Preprocessing is an important step to remove noise and other undesirable content that can cause inaccuracies in the image processing techniques. The paper proposes two filters - Wiener and Median - for denoising the microscopic images. The filters were compared for accuracy in denoising and the median filter was found to outperform the Wiener filter in terms of Peak Signal to Noise Ratio, which can be used for better image classification in later stages. The proposed method was tested on 35 real-time images with Gaussian noise[2].

Anitha S, et.al (2023) conducted study on "Analysis of Filtering and Novel Technique for Noise Removal in MRI and CT Images" MRI is a non-invasive technique that uses magnetic and radio waves to produce clear images of tissue and organs without harmful radiation. It plays a crucial role in the diagnosis and treatment of brain, ankle, foot, and prostate cancer. However, obtaining accurate images can be challenging due to various noise sources such as speckle, Poisson, salt and pepper, and Gaussian noise. To address this, noise removal filters like median, KSL, and Wiener filters are used. This paper discusses and compares the performance of median and Wiener filtering algorithms in removing noise from MRI and CT images, and evaluates the image quality using metrics like PSNR, RMSE, and MSE [3].

Yanqiu Zeng, et.al (2020) study focused on "Magnetic Resonance Image Denoising Algorithm Based on Cartoon, Texture, and Residual Parts" This paper proposes a hybrid denoising algorithm for magnetic resonance images to improve their quality and reliability. MR images are often contaminated by Gaussian noise, which reduces their quality. The algorithm decomposes the noisy MR image into the cartoon, texture, and residual parts by MCA and denoises each part using Wiener filter, wavelet hard threshold, and wavelet soft threshold, respectively. The denoised subimages are then stacked up to obtain the denoised MR image. Experimental results show that the proposed method outperforms each method alone in terms of mean square error and peak signal-to-noise ratio[34].

Wirawan Setyo Prakoso et.al (2020) study focused on "Enhancement Methods of Brain MRI Images: AReview" This study reviews current methods for enhancing the quality of magnetic resonance imaging in the context of brain imaging, with the aim of identifying the strengths and weaknesses of each method for detecting tumors. Preprocessing steps such as artifact elimination, skull despoil, noise elimination, and image quality enhancement are covered. The study reveals that the Average Intensity Reinstatement placed on Adaptive Histogram equalization is the best preprocessing method for clinical datasets, while the combined Contrast Guided Interpolation and Iterative back-projection methods are the best for the Brainweb dataset. The Non-Local Means Filter is the best for the clinical dataset due to its low Mean Squared Error value[35].

Shakunthala M, et.al (2019) conducted study on “preprocessing analysis of brain images with atherosclerosis” Cerebral Atherosclerosis is a serious condition that can cause acute neurological deterioration, especially in young and middle-aged women. To detect this condition from MRI images, image enhancement techniques are required. Preprocessing techniques are necessary to obtain accurate results from the enhanced image. This paper presents a comparative analysis of commonly used filters such as mean, median, alpha trimmed mean, weighted median, adaptive median, bilateral, and Wiener filters on MRI brain images, and optimal PSNR and MSE are determined. This study can help in identifying the best filter for enhancing MRI brain images for the detection of Cerebral Atherosclerosis[60].

Hiba mzoughi, et.al (2018) study focused on “Histogram Equalization-Based Techniques for Contrast Enhancement of MRI Brain Glioma Tumor Images: Comparative Study” The study uses real-world databases and evaluates the techniques using quality measurement metrics such as AMBE, PSNR, and Entropy. The advantages and limitations of the studied techniques are also discussed. Magnetic Resonance Imaging (MRI) can produce poor image quality due to artifacts and low tissue contrast, which can affect clinical diagnosis accuracy. To improve the image contents, image enhancement techniques have been proposed, particularly MRI denoising techniques. Among them, histogram-based approaches are commonly used for contrast enhancement. This paper presents a comparative study of four histogram-based techniques (AHE, CLAHE, BPDHE, and AIR-AHE) for denoising and contrast enhancement of MRI images[70].

R.V. Suryavamsi, et.al (2018) study focused on “Comparative Analysis of Various Enhancement Methods for Astrocytoma MRI Images” Image processing is essential for obtaining information from brain images, particularly for diagnosing various diseases using Magnetic Resonance Imaging (MRI) techniques. Pre-processing procedures such as artifact removal, skull stripping, noise removal, and enhancement are necessary, especially for easy detection of tumors. This paper analyzes three methods (HE, CLAHE, BPDFHE) on astrocytoma MRI brain images and evaluates the results using performance metrics. The proposed methods are verified and show promise for improving tumor detection in MRI images[71].

Isa, S. N Sulaiman, M.F.et.al (2017) presented study on "New Image Enhancement Technique for WMH Segmentation of MRI FLAIR Image" This paper proposes a new image enhancement technique called Average Intensity Replacement based on Adaptive Histogram Equalization for fluid attenuated inversion recovery MRI images. The algorithm includes partial contrast stretching, contrast limiting enhancement, window sliding neighborhood operation, and new pixel centroid replacement. FLAIR images used for segmentation have low contrast, so contrast stretching is used to improve image quality. The technique identifies potential areas of white matter hyper intensities by detecting high-intensity regions. The proposed method moderately enhances WM hyper regions without compromising brightness, providing natural improvement for the periventricular region[79].

2.3.2 COMPARATIVE ANALYSIS FOR FILTERING TECHNIQUES

Following the literature survey conducted in previous research on different filters:

Md. Alamin Talukder a, et.al (2023) presented study on "an effective identification and analysis for brain tumor diagnosis using an efficient machine learning technique" The use of machine learning diagnostic image detection can assist surgeons in clinical diagnosis of brain tumor disease, but it requires a large amount of labeled data for effective detection. Diagnosing the disease is crucial to prevent its rapid rise, and a novel Tiger-based Support Vector Machine technique was proposed for this purpose. The technique involves preprocessing, feature extraction, prediction, and segmentation stages, which utilize the wiener filter and GLCM feature extraction method to provide accurate results. The proposed model was compared with other methods using various metrics[4].

P. Sankar Ganesh, et.al (2021) conducted study on "Brain Tumor Detection and Classification Using Image Processing Techniques" Medical image processing is an important and developing field that involves various imaging methods, such as CT scans, X-rays, and MRI. These technologies help in identifying even the smallest defects in the human body, including abnormal tissue growth that affects brain function. The main objective of medical image processing is to obtain accurate and meaningful information using images with minimum errors. MRI is commonly used to obtain high-quality images of the human body and cancerous tissues. Brain tumor identification through MRI images is a complex task due to the brain's complexity, and various segmentation techniques can be used to identify and extract tumors from MRI images. The process of identifying brain tumors through MRI images can be divided into four stages: preprocessing, image segmentation, feature extraction, and image classification[13].

Subhrajit Dey et.al (2021) presented study on "Median Filter Aided CNN Based Image Denoising: An Ensemble Aprroach" This paper proposes an ensemble learning model for denoising images contaminated with additive white Gaussian noise. The model combines the outputs of three denoising models, namely ADNet, DnCNN, and IRCNN, in a specific ratio. The first model (ADNet) uses Convolutional Neural Networks with attention and median filter layers. The second model (DnCNN) is a feed forward denoising CNN, and the third model (IRCNN) uses dilated convolutional layers and median filter layers. The proposed model outperforms other state-of-the-art models on BSD500 and Set12 datasets, as per quantitative analysis[14].

Abhishek Sharma, et.al (2021) presented study on "MRI denoising using advanced NLM fltering with non-subsampled shearlet transform" This research proposed a novel denoising technique for MRI images that combines the advanced NLM method with non-subsampled shearlet transform. The NLM filter is modified for better noise detection, and parameters are set for maximum output and high-quality denoising. The proposed method outperforms existing state-of-the-art methods in terms of PSNR, SSIM, and RMSE values. The proposed technique effectively removes noise from MRI images. Several denoising techniques, such as bilateral filter, wavelet transform, maximum likelihood, and non-local means, have been introduced for MRI images. However, these methods have limitations [15].

Keya Huang, et.al (2021) presented study on "Image Noise Removal Method Based on Improved Nonlocal Mean Algorithm" The paper proposes an improved image processing algorithm for nonlocal mean denoising to address the problem of unclear images in interactive systems. The algorithm combines the adaptive median filter and nonlocal mean algorithm to denoise mixed noise effectively. The algorithm adjusts the image window adaptively, selects corresponding pixel weight, and denoises the image. Experimental results show that the proposed algorithm outperforms the traditional nonlocal mean algorithm in terms of visual quality and PSNR of complex noise images[16].

D.M. Mahalakshmi et.al (2020) conducted study on "performance analysis of svm and deep learning with cnn for brain tumor detection and classification" Medical imaging is advantageous in the diagnosis of brain tumors, which are a serious and dangerous disease. However, the detection and classification of brain tumors are difficult tasks due to the high quantity of data in MRI images. Image segmentation is essential in detecting the tumor, and Mean Shift Clustering is used for this process. The segmented tumor undergoes feature extraction, and Gray Level Co-occurrence Matrix features are used. The images are classified using Support Vector Machine or Deep Learning with Convolutional Neural Network. The proposed system is tested using PSGIMSR dataset and implemented using MATLAB software, achieving reasonable accuracy with minimum computational time. Early detection of the tumor region can be achieved without much time lapse in the calculation by using this efficient classifier model[36].

Sheela, et.al (2020) presented study on “Median Filter for Denoising MRI” This paper proposes a method for reducing noise from MRI to improve medical image segmentation and early detection of Alzheimer's disease. Gaussian noise and Salt and pepper noise are common in medical images, and denoising techniques such as the median filter have proven effective. The proposed method uses an extension of the median filter to detect noisy pixels and uses 3x3 size windows to obtain better information about center neighbors. The algorithm was tested on noise levels ranging from 20% to 80% and applied to the Alzheimer's disease Neuroimaging Initiative database. Results showed the effectiveness of the proposed algorithm compared to standard and other improvements[37].

Priya Sagar, et.al (2020) conducted study on “A Circular Adaptive Median Filter for Salt and Pepper Noise Suppression from MRI Images” The article presents a circular adaptive median filter (CAMF) for denoising MRI images corrupted by salt and pepper noise. The filter incorporates an adaptive operation by varying the size of the circular kernel. The proposed approach is compared with six other competitive networks, and its performance is evaluated using PSNR and computational time. A non-parametric statistical test is conducted to compare the proposed filter with other filters, and it is observed that the CAMF outperforms the other filters in terms of PSNR and computational time[38].

Alam Noor, et.al (2020) study focused on “Median filters combined with denoising convolutional neural network for Gaussian and impulse noises” A new filter for eliminating combined Gaussian and impulse noises in digital images is proposed in this work. The filter combines median filters and convolutional neural networks to preserve image details and suppress noise. The method includes two steps: detection of impulse noise using median filters, and removal of Gaussian noise using residual learning denoising convolutional neural networks. The proposed method achieves good image quality and low loss and root mean square error during training, as well as high peak signal to noise ratio and low mean square error in experimental results[39].

Narendra Kumar,et.al (2020) presented study on "Modified Median Filter for Image Denoising" A new approach for removing salt and pepper noise from images is proposed in this article. The proposed methodology is based on a different median filter. The paper presents the methodology and logical notations of the proposed technique and measures image quality using PSNR. The results are compared with proven filtering methods, and the proposed approach shows promising results. Overall, the goal is to retrieve the original image quality, which is always a challenging task in image processing[40].

T. Kalaiselvi, et.al (2020) study focused on "Two Scale Adaptive Median Filter for Denoising MRI Images" The paper introduces a two-scale adaptive median filter for denoising MRI scans. The proposed filter modifies the adaptive median filter parameters to account for signal-dependent Rician noise. The two-scale adaptive median filter is evaluated against existing methods using qualitative and quantitative measures. The results show that the proposed method outperforms the existing methods in terms of denoising effectiveness[41].

Maxime Descoteaux, et.al (2020) presented study on "Impact of Rician Adapted Non-Local Means Filtering on HARDI" This paper studies the impact of denoising raw high angular resolution diffusion imaging (HARDI) data with the Non-Local Means filter adapted to Rician noise (NLMr). The study shows that NLMr filtering improves the robustness of apparent diffusion coefficient and orientation distribution function reconstructions from synthetic HARDI datasets. The results demonstrate that NLMr filtering improves the quality of anisotropy maps and coherence of q-ball ODFs with the underlying anatomy without degrading angular resolution. The study concludes that NLMr filtering can avoid the need for multiple measurements of diffusion-weighted images, producing better quality generalized fractional anisotropy maps and more accurate ODF fields[42].

Mei Gao,et.al (2019) presented study on "Anisotropic Diffusion Based Multiplicative Speckle Noise Removal" The paper proposes an anisotropic diffusion model for removing multiplicative speckle noise in images, based on image statistics such as gradient, gray levels, and noise standard deviation. The model is improved to consider edge noise by decomposing the divergence term. Iteration stopping criteria based on kurtosis and correlation are proposed, and parameter values are obtained through learning. Post-processing is performed for improved denoising. Simulation results show that the proposed model effectively removes speckle noise while retaining image details for real ultrasound and RGB color images[61].

Resmi R. Nair, et.al (2019) study focused on "A robust anisotropic diffusion filter with low arithmetic complexity for images" This paper presents a low arithmetic complexity image smoothing model for anisotropic diffusion smoothing of images. Anisotropic diffusion smoothing filters are known to be not robust to impulse noise and require increased arithmetic operations for robustness. The proposed algorithm is intrinsically robust and power-efficient, outperforming the foundational robust smoothing algorithms in terms of standard performance metrics and visual quality. The method addresses the challenge of image smoothing with edge preservation in the presence of outliers, making it a valuable tool in digital image processing[62].

Dr. Sana'a khudayer Jadwa, et.al (2018) presented study on "Wiener Filter based Medical Image De-noising" This paper proposes an effective noise reduction approach using the Wiener filter to improve the quality of various medical imaging modalities. The proposed approach shows promise for enhancing the quality of medical images for improved diagnosis and treatment. Medical images such as CT scan and MRI provide important information for diagnosis and treatment, but they are often affected by various types of noise during acquisition, storage, and transmission. This can compromise the quality of disease diagnosis or treatment. Image de-noising is a process used to remove noise from naturally corrupted images[72].

Anchal, et.al (2018) conducted study on "An Efficient Image Denoising Scheme for Higher Noise Levels Using Spatial Domain Filters" The paper proposes an image denoising algorithm that addresses the challenge of denoising at higher noise levels while preserving edge information. The proposed algorithm combines robust bilateral filtering with anisotropic diffusion filtering. Experimental results show that the proposed method works better for higher noise levels in terms of PSNR values and visual quality. The standard bilateral filter does not provide good results at higher noise levels, and many denoising mechanisms degrade with increasing noise levels, leading to significant information loss. The proposed algorithm addresses these issues and achieves better results for higher noise levels [73].

Debesh Jha, et.al (2017) presented study on "Pathological Brain Detection Using Weiner Filtering, 2D-Discrete Wavelet Transform, Probabilistic PCA, and Random Subspace Ensemble Classifier" Accurate diagnosis of pathological brain images is crucial for patient care, especially in the early stages of the disease. Machine-learning techniques have been used for computer-aided diagnosis (CAD) of pathological brain, but previous methods faced challenges in diagnostic efficiency due to insufficient filtering techniques, neuroimaging biomarkers, and limited learning models. A new proposed model includes Wiener filtering, 2D-discrete wavelet transform, probabilistic principal component analysis, and a random subspace ensemble classifier with the K-nearest neighbors algorithm to classify brain images as pathological or normal. The proposed method outperforms 21 state-of-the-art algorithms in terms of classification accuracy, sensitivity, and specificity for all four datasets used in the study based on 5x5 cross-validation. MRI is used to provide enhanced information regarding the soft tissues[80].

Ercument Yilmaz , et.al (2017) conducted study on "Noise Removal of CBCT Images Using an Adaptive Anisotropic Diffusion Filter" The study proposes an adaptive anisotropic filtering method for removing noise from CBCT images. The method is tested on 1200 different image sections obtained from 30 different patients. Noise levels in CBCT dataset sections are measured using a noise level estimation method to identify 2D image sections that do not contain noise information. Different levels of noise are applied to those noise-free images and the proposed adaptive anisotropic diffusion filter is compared to other filtering methods. Results show that the proposed filter is a good choice for removing noise that may occur on CBCT image sections[81].

Jiangtao Xu, et.al (2016) presented study on "An improved anisotropic diffusion filter with semi-adaptive threshold for edge preservation" This paper proposes a noise removal method using a semi-adaptive threshold in an anisotropic diffusion filter to preserve detail information while suppressing noise. The method involves replacing some corrupted pixels with pre-denoised pixels using a Gaussian filter, followed by applying an anisotropic diffusion model with a semi-adaptive threshold in diffusion coefficient function. The gradient value of the corrupted pixels is introduced in the threshold to achieve more diffusion in smooth areas and less diffusion in boundary regions. Experimental results show that the proposed method outperforms traditional anisotropic diffusion models, improving PSNR by 30% and SSIM by 5%. The method is efficient in both edge preservation and noise removal[89].

Jian Yang, et.al (2015) presented study on "Brain MR image denoising for Rician noise using pre-smooth non-local means filter" MRI is a medical imaging technique that is affected by Rician noise, which makes image-based quantitative measurement difficult. The NLM filter has been effective against additive noise, and a pre-smoothing NLM filter combined with image transformation has been proposed to address Rician noise. In the pre-smoothing NLM filter, the noisy MRI is transformed and pre-smoothed before the NLM filter is applied, with inverse transformation performed to obtain the denoising results. The proposed method was tested on simulated and real patient data, and its performance was evaluated through visual inspection and quantitative comparison of the peak signal-to-noise ratio of the simulated data. The real patient data included Alzheimer's disease patients and normal controls, and the proposed method was evaluated by detecting atrophy regions in the hippocampus and parahippocampal gyrus[94].

N. Hema Rajini, et.al (2012) conducted study on “Automatic Classification of MR Brain Tumor Images Using Decision Tree” A tumor classification system has been developed to classify five types of tumors using magnetic resonance feature images. The proposed method consists of three stages: pre-processing, feature extraction, and classification. The noise is removed using a wiener filter in the pre-processing stage. In the feature extraction stage, six texture features are extracted using the gray level co-occurrence matrix. Finally, a decision tree classifier is used to classify the tumor type by comparing the extracted features with the stored features in the knowledge base. The system was evaluated on a dataset of 21 patients and achieved a 98% success rate. Magnetic resonance imaging is a widely used method for high-quality medical imaging, especially in brain imaging [104].

C. Shyam Anand, et.al (2010) conducted study on “Wavelet domain non-linear filtering for MRI denoising” This article presents a wavelet-based bilateral filtering scheme for noise reduction in magnetic resonance images, which preserves edge features. The scheme uses undecimated wavelet transform to effectively represent noisy coefficients, and bilateral filtering of the approximate coefficients improves denoising efficiency. Denoising is performed in the square magnitude domain, where the noise is signal-independent and additive. The proposed method is specifically adapted to Rician noise and preserves visual and diagnostic quality of the denoised image. The method demonstrates the ability for noise suppression through quantitative and qualitative quality metrics[109].

Jose´ V. Manjo, et.al (2008) conducted study on “MRI denoising using Non-Local Means” This study analyzes and adapts the NLM filter, which is highly dependent on its parameters, to reduce noise in MR magnitude images. The aim is to find optimal parameter settings for MR magnitude image denoising and to adapt the filter to fit specific characteristics of Rician noise in MR magnitude images. Experiments were conducted to find optimum parameters for different noise levels, and the results show that the filter can be successfully used for automatic MR image denoising. Random noise affects the accuracy of quantitative measurements in Magnetic Resonance images[114].

2.4 SEGMENTATION OF THE BRAIN MRI IMAGE

Brain tumor localization and segmentation from MRI are hard and important tasks for several applications in the feld of medical analysis. As each brain imaging modality gives unique and key details related to each part of the tumor, many recent approaches used four modalities T1, T1c, T2, and FLAIR. Although many of them obtained a promising segmentation result on the BRATS 2018 dataset, they sufer from a complex structure that needs more time to train and test. the manual segmentation and analysis of structural MRI images of brain tumors is an arduous and time-consuming task which, thus far, can only be accomplished by professional neuroradiologists . Therefore, an automatic and robust brain tumor segmentation will have a signifcant impact on brain tumor diagnosis and treatment.

2.4.1 IMAGE SEGMENTATION TECHNIQUES

Most of the image segmentation algorithms are based on two basic properties of intensity values: discontinuity and similarity. The first approach is to segment the image based on abrupt change in intensity, such as edged in the images. The second approach is based on some pre-defined criteria upon which images are partitioned.

Segmentation can be classified as:

2.4.1.1 EDGE DETECTION BASED IMAGE SEGMENTATION

In image segmentation process, Edge detection is the basic step used to find the boundaries of objects within images. The edge detection is obtained by identifying the sharp changes or discontinuities in brightness.It usually involves arranging points of discontinuity into curved line segments, or edges. The edge detection for image segmentation methods are Gray histogram and Gradient methods. Several operators are used by edge detection method, i.e., Classical edge detectors, zero crossing, Canny Edge detector, Sobel, Prewitt, Roberts Laplacian of Guassian and color edge detectors etc[108].

2.4.1.2 REGION BASED IMAGE SEGMENTATION

Region Based Segmentation are relatively simple and more immune to noise compared to edge detection method. In region-based methods, partition an image into regions that are similar according to a set of predefined criteria. Region based segmentation methods are divided into three main parts, i.e., region growing, region splitting, and region merging. Region growing is a region-based sequential technique in neighboring pixels are scanned and added into larger regions based on predefined seed pixels, growing criteria and stop conditions[123].

2.4.1.3 CLUSTERING BASED IMAGE SEGMENTATION

Clustering is a powerful technique in image segmentation. There are several clustering methods such as k means, adaptive k means, fuzzy c means (FCM) and improved fuzzy c mean algorithm (IFCM). K-Means clustering algorithm is an unsupervised algorithm used to segment the wanted area from the background. It clusters, or divides the given data into K-clusters.

2.4.1.4 NEURAL NETWORK BASED IMAGE SEGMENTATION

Neural networks are an interconnected collection of nodes called neuron. Every neuron takes one piece of the input data, typically one pixel of the image, and applies a simple computation, called an activation function to generate a result. Each neuron has a numerical weight that affects its result. That result is fed to additional neural layers until at the end of the process the neural network generates a prediction for each input or pixel[9].

2.4.1.5 THRESHOLD BASED IMAGE SEGMENTATION

Thresholding is the most common method of image segmentation. Thresholding is a image segmentation technique to convert a multilevel image into a binary image i.e., it choose a proper threshold value to divide image pixels into several regions and separate objects from background. Different thresholding techniques proposed by different researchers are Otsu thresholding, P-tile method, Histogram dependent technique, Edge Maximization technique, Mean method, and visual technique[118].

2.4.2 COMPARATIVE ANALYSIS FOR IMAGE SEGMENTATION TECHNIQUES

Image Thresholding is a simple and effective method to separate objects from the background in an image. The basic idea behind thresholding is to set a threshold value and classify pixels as either foreground or background based on their intensity values. There are different types of thresholding techniques, such as global thresholding, adaptive thresholding, and Otsu's thresholding. Global thresholding involves selecting a fixed threshold value for the entire image, while adaptive thresholding uses a local threshold value that varies across the image. Otsu's thresholding is an optimal thresholding technique that finds the threshold value that minimizes the variance between the two classes of pixels (foreground and background). Thresholding can be effective for images with high contrast and well-defined object boundaries, but may not work well for images with low contrast or uneven lighting conditions. It can also produce noisy results when the foreground and background have similar intensities. Thresholding is a widely used image processing technique that separates objects from the background in an image by classifying pixels as either foreground or background based on their intensity values. The basic idea behind thresholding is to set a threshold value and compare the intensity values of each pixel in the image with this threshold. If the intensity value is above the threshold, the pixel is classified as foreground, otherwise, it is classified as background. There are Two types of Thresholding as follows:

Bi-level thresholding is a technique used in image processing to segment an image into two regions, typically for the purpose of separating an object from the background. In bi-level thresholding, a threshold value is chosen such that all pixel intensities below the threshold are classified as one region (usually the background), and all pixel intensities above the threshold are classified as the other region (usually the object). an image is segmented into two regions based on the threshold level, the dividing factor, thresholding level will be selected on the histogram, Otsu’s technique of segmentationis such a method widespread histogram-based thresholding method by computing an optimized threshold value based on the condition, to maximize the variance between the different regions. There are different algorithms and techniques used for bi-level thresholding, including global thresholding, Otsu's method, and adaptive thresholding. In global thresholding, a single threshold value is applied to the entire image, while in adaptive thresholding, the threshold value is determined locally based on the intensity values of the neighboring pixels. Otsu's method is a popular technique for determining an optimal threshold value based on the histogram of the image intensities.

Multilevel thresholding is a process that segments a gray level image into several distinct regions. This technique determines more than one threshold for the given image and segments the image into certain brightness regions, which correspond to one background and several objects. Multilevel thresholding is a technique used in image processing and computer vision to segment an image into multiple regions based on their intensity values. In multilevel thresholding, the image is partitioned into multiple subregions by assigning threshold values to the intensity range of the image. Survey of the Different Multithresholding Algorithms for MRI Brain Images as follows:

S. Ayshwarya Lakshmi, et.al (2023) conducted study on “Enhanced Cuckoo Search Optimization Technique for Skin Cancer Diagnosis Application” The proposed enhanced cuckoo search algorithm is used for skin cancer segmentation in a clinical decision support system. This algorithm is an effective global optimization strategy that outperforms other conventional methods in terms of accuracy, sensitivity, and specificity. The enhanced optimization technique achieved 98.75% and 98.96% for Dice and Jaccard coefficient, respectively. The proposed method offers a 23% to 29% improvement over other optimization algorithms and achieves an accuracy of 99.26%. The model trained using this measure outperforms those trained using conventional methods in segmenting skin cancer picture data[5].

Javaria Amin, et.al (2022) study focused on “Brain tumor detection and classification using machine learning: a comprehensive survey “This survey provides a comprehensive overview of brain tumor detection through magnetic resonance imaging (MRI). Brain tumor detection is a challenging task due to variations in tumor location, shape, and size. The survey covers various topics, including anatomy of brain tumors, publicly available datasets, enhancement techniques, segmentation, feature extraction, classification, and deep learning, transfer learning, and quantum machine learning for brain tumor analysis. The survey aims to provide researchers with a comprehensive literature review and insights into the advancements, limitations, and future trends in brain tumor detection [8].

Fatma A. Hashim, et.al (2022) conducted study on “Archimedes optimization algorithm: a new metaheuristic algorithm for solving optimization problems “The paper introduces a new metaheuristic algorithm called Archimedes optimization algorithm that imitates Archimedes' Principle. AOA is tested on CEC'17 test suite and four engineering design problems and is compared to other well-known metaheuristic algorithms such as GA, PSO, L-SHADE, LSHADE-EpSin, WOA, SCA, HHO, and EO. The results showed that AOA outperformed all of them, proving its efficiency in solving complex optimization problems[10].

Essam H. Houssein, et.al (2021) conducted study on "Improved manta ray foraging optimization for multi-level thresholding using COVID-19 CT images" The paper proposes an efficient version of the MRFO algorithm based on opposition-based learning called the MRFO-OBL algorithm to extract regions of interest from COVID-19 CT images. The MRFO-OBL algorithm improves population variety in the search space and solves the image segmentation problem using multilevel thresholding. It is evaluated using Otsu's method over the COVID-19 CT images and compared with six meta-heuristic algorithms. The experimental results demonstrate that the proposed method outperforms the original MRFO and the other compared algorithms under Otsu's method for all the used metrics[17].

Yuncong Feng, et.al (2021) conducted study on "An Interval Iteration Based Multilevel Thresholding Algorithm for Brain MR Image Segmentation" The proposed interval iteration multilevel thresholding method (IIMT) for brain MR image segmentation is based on the Otsu method but iteratively searches for sub-regions of the image to achieve segmentation. The algorithm decomposes the original image using a hybrid L-L layer decomposition method to obtain the base layer, followed by applying IIMT to segment both the original image and its base layer. The two segmentation results are integrated by a fusion scheme to obtain a more refined and accurate segmentation result. Experimental results show that the proposed algorithm is effective and outperforms the standard Otsu-based and other optimization-based segmentation methods[18].

Renugambal, et.al (2021) conducted study on "Kapur's Entropy based Hybridised WCMFO Algorithm for Brain MR Image Segmentation" The article proposes a multilevel thresholding method for brain MR image segmentation called the Kapur-based hybridized Water Cycle and Moth-Flame Optimisation (WCMFO) algorithm. It combines the water cycle algorithm (WCA) and moth flame optimisation (MFO) to achieve faster convergence with broader exploration and exploitation capabilities. Experiments on 10 axial, T2-weighted test images were performed, and the proposed algorithm outperformed other existing adaptive wind-driven optimization algorithm, adaptive bacterial foraging, and particle swarm optimization algorithms. The best segmentation is achieved on grey matter, white matter, and cerebrospinal fluid, allowing for better clinical decision-making and diagnosis[19].

Houseein, et.al (2021) presented study on “A Study on Darwinian Crow Search Algorithm for Multilevel Thresholding” This paper introduces a novel multilevel thresholding algorithm based on Cuckoo search for image segmentation. To overcome the shortcoming of stagnation phenomenon, the idea of Darwinian theory is incorporated into the CS algorithm. The algorithm is implemented based on dividing the population into specified groups and each group tries to find a better location. Experimental results show that the introduced algorithm outperforms other heuristic search methods and is a powerful tool for multilevel thresholding in image segmentation [20].

Jarjish Rahaman, et.al (2021) conducted study on “An efficient multilevel thresholding based satellite image segmentation approach using a new adaptive cuckoo search algorithm” This paper presents a new adaptive cuckoo search algorithm for satellite image segmentation, which overcomes the challenges of randomness and weak correlation of pixels. The proposed algorithm is compared with CSMcCulloch incorporating McCulloch's method for levy flight generation in CS algorithm by using two different objective functions, and performance is measured using various metrics such as PSNR, MSE, FSIM, SSIM, UIQI, and computational time. The proposed approach results in improved segmentation quality and reduced computational time, and the convergence rate is superior to the CSMcCulloch algorithm. The results suggest that the proposed algorithm can be useful in various domains, such as computer vision, medical image analysis, machine learning, and deep learning[21].

Yogendra Kumar, et.al (2021) conducted study on “A survey on Cuckoo Search Algorithm for Optimization Problems” This paper gives an overview of the cuckoo search algorithm and its recent applications and developments in the past decade. It summarizes the literature of the last decade (2009-2019) about cuckoo search, published in peer-reviewed journals and conferences. The paper provides a systematic classification of the references into appropriate categories that can be used as a basis for further research in cuckoo search. Overall, the paper serves as a comprehensive guide for researchers interested in the cuckoo search algorithm[22].

Shahil kumar, et.al (2021) conducted study on “A Multilevel Image Thresholding Method Using the Darwinian Cuckoo Search Algorithm” The paper introduces a novel multilevel thresholding algorithm based on Cuckoo search for image segmentation. To overcome the stagnation phenomenon of metaheuristic algorithms, the idea of Darwinian theory is incorporated with CS algorithm to increase diversity and quality of individuals without decreasing the convergence speed. The algorithm is implemented based on dividing the population into specified groups and a policy of encouragement and punishment is considered to reduce computational time. The experimental results show that DCS outperforms the CS algorithm and other heuristic search methods in terms of multilevel thresholding and evaluation criteria[23].

Longzhen Duan, et.al (2021) study focused on "Multilevel thresholding using an improved cuckoo search algorithm for image segmentation" The paper proposes an improved cuckoo search algorithm (ICS) for multilevel thresholding image segmentation, using Otsu as its objective function. Two modifications are used in ICS, a parameter adaptation strategy to improve exploration performance and a dynamic weighted random-walk method to enhance local search efficiency. The experiments are conducted on six benchmark test images and compared with seven state-of-the-art metaheuristic algorithms. Results indicate that the proposed algorithm is superior to other seven well-known heuristic algorithms based on various measures such as objective function value and standard deviation, PSNR, FSIM, and SSIM [24].

Wentan Jiao,et.al (2021) presented study on "An Improved Cuckoo Search Algorithm for Multithreshold Image Segmentation" This paper proposes an improved cuckoo search algorithm (ICS) for multithreshold image segmentation to overcome the disadvantages of long computation time and poor quality. The ICS algorithm is enhanced using a chaotic initialization population, optimized step size factor, and probability to reduce algorithm complexity. The maximum entropy threshold function is used as the fitness function for the cuckoo search algorithm in image segmentation. Simulation experiments demonstrate that the proposed algorithm has good segmentation performance under different thresholding conditions[25].

K. Suresh Manic, et.al (2021) conducted study on "Extraction and Evaluation of Corpus Callosum from 2D Brain MRI Slice: A Study with Cuckoo Search Algorithm" The paper proposes a computer-based diagnosis method (CBDM) to extract and evaluate the corpus callosum (CC) segment from 2D brain MRI images. The CBDM comprises a multithreshold technique with the chaotic cuckoo search algorithm for preprocessing and a delineation process for postprocessing. The proposed CBDM is employed to classify the considered MRI slices into the control and autism spectrum disorder (ASD) groups, and the results indicate its superiority over existing methodologies. The experimental outcomes demonstrate that the proposed CBDM provides more accurate CC extraction from 2D MR brain images[26].

Kalpana R,et.al (2020) study focused on "An optimized technique for brain tumor classification and detection with radiation dosage calculation in MR image "The early detection and proper treatment of brain tumors are crucial to prevent damage to the brain. Magnetic Resonance (MR) is a radiology technique used for medical imaging to locate the tumor's size and position accurately. This paper presents a novel approach for brain tumor segmentation using MLTS-HSO and different classifiers, such as KNN, DSVM, NB, and RBFN. The proposed system accurately predicts the tumor's size and position, enabling more precise surgical and therapy procedures with better performance metrics and radiation dosage calculations[43].

S. N. Kumar, et.al (2020) conducted study on "Multilevel thresholding using crow search optimization for medical images" This research paper discusses the importance of multilevel thresholding in medical image segmentation and how optimization algorithms play a vital role in selecting threshold values. Various optimization techniques such as electromagnetic optimization, harmony search optimization, and crow search optimization were employed to select the optimum threshold values. The results showed that the crow search optimization technique was efficient in multilevel thresholding segmentation with less complexity and fewer parameter tunings. The algorithms were tested on real-time CT abdomen DICOM datasets, and the evaluation of performance metrics revealed the efficiency of the crow search optimization approach[45].

R. Srikanth, et.al (2020) conducted study on "Multilevel thresholding image segmentation based on energy curve with harmony Search Algorithm" The paper proposes a novel approach for image segmentation using the Energy Curve instead of the histogram, along with the Otsu's method and Harmony Search Algorithm for computing optimized gray levels. The proposed method is tested on several benchmark images and evaluated based on metrics such as Dunn Index, DB Index, SD Index, mean of fitness, and PSNR. The comparison with other optimization algorithms using histograms shows that the proposed method is superior and provides better spatial details and contextual information for finding optimal threshold levels[46].

Akankshya Das, et.al (2020) conducted study on "State-of-the Art Optimal Multilevel Thresholding Methods for Brain MR Image Analysis" This paper provides a comprehensive review of recent advancements in brain MR image segmentation using optimal multilevel thresholding, a widely used method due to its precision and robustness. Various optimization algorithms have been used to address the problem of computational complexity in increasing threshold levels. The review discusses different validation measures and compares the results obtained over the years, highlighting the strengths and weaknesses of each method. The paper aims to aid and encourage researchers to further explore this area of research[47].

Lahbib KHRISSI, et.al (2020) conducted study on "Simple and Efficient Clustering Approach Based on Cuckoo Search Algorithm" The paper proposes a new image segmentation approach that combines the unsupervised classification method fuzzy C-means (FCM) with a metaheuristic called CSA. CSA is used to find the optimal partitioning according to an objective function based on the indices of validity of the clusters. The proposed approach was tested on several images and compared to other FCM techniques like standard FCM and FCM based on genetic algorithms. The experimental results show that the proposed approach achieves satisfactory results in terms of precision, simplicity, and efficiency. The paper highlights the importance of image segmentation in image processing and analysis and the need for a versatile segmentation technique that can be applied to different types of images in various computer contexts[48].

Afshin Faramarzi, et.al (2019) study focused on "Equilibrium optimizer: A novel optimization algorithm" This paper introduces a new optimization algorithm called Equilibrium Optimizer (EO), inspired by control volume mass balance models used to estimate both dynamic and equilibrium states. EO uses particles and their concentration as search agents to reach the equilibrium state or optimal result. The algorithm is tested with 58 mathematical functions and three engineering problems, and is benchmarked against various meta-heuristics, recently developed algorithms, and high performance optimizers. The results show that EO outperforms several well-known optimization algorithms, including PSO, GWO, GA, GSA, SSA, and CMA-ES. It is also shown to be statistically similar to SHADE and LSHADE-SPACMA in terms of performance[44].

Omid Tarkhaneh, et.al (2019) conducted study on "An adaptive differential evolution algorithm to optimal multi-level thresholding for MRI brain image segmentation" This paper proposes a new adaptive Differential Evolution solution for multi-level thresholding in MRI medical image segmentation, which balances exploration and exploitation through a new adaptive approach and new mutation strategies. Experimental results show that the proposed solution outperforms three benchmark algorithms in terms of efficiency, accuracy and stability[63].

Farah Aqilah Bohani, et.al (2019) conducted study on “Multilevel Thresholding of Brain Tumor MRI Images: Patch-Levy Bees Algorithm versus Harmony Search Algorithm” This study compares two nature-inspired metaheuristic algorithms, Harmony Search (HS) and Patch-Levy Bees Algorithm (PLBA), for multilevel thresholding in brain tumor segmentation using MRI. Manual segmentation is prone to errors, making automated segmentation methods crucial in the diagnostic process. Results from a test dataset of nine images showed that PLBA outperformed HS in terms of solution quality and stability. This study demonstrates the potential of metaheuristic algorithms in improving automated segmentation methods for brain MRI analysis[64].

R Kalyani, et.al (2019) conducted study on “Image segmentation with Kapur, Otsu and minimum cross entropy based multilevel thresholding aided with cuckoo search algorithm” This paper presents a method for color image segmentation using multilevel thresholding (MLT) and the CSA with objective functions such as Kapur, Otsu, and minimum cross entropy. The CSA algorithm's parameter is used to balance local and global search. The results show that the Otsu-based CSA algorithm outperforms Kapur and MCE in terms of quality metrics such as computational time, PSNR, and SSIM for precise image segmentation at 4, 5, 6, and 7 threshold levels. The study confirms the efficacy of CSA in real-world applications[49].

V.rajinikanth, et.al (2018) conducted study on “Segmentation of mammogram images using level set with Cuckoo search optimization” The proposed method of using multiphase level set segmentation with the cuckoo search approach for energy minimisation is effective in segmenting both homogeneous and inhomogeneous regions in low contrast mammograms for breast cancer detection. The method outperforms the classical Chan Vese method and is validated using performance measures such as Jaccard coefficient, dice coefficient, Hausdorff distance, sensitivity, specificity, and accuracy on the Mammographic Image Analysis Society database. The results demonstrate the effectiveness of the proposed approach for accurately segmenting breast masses in mammograms[74].

R. Sumathi, et.al (2018) conducted study on “Extracting tumor in MR brain and breast image with Kapur's entropy based Cuckoo Search Optimization and morphological reconstruction filters” The proposed method uses Kapur's entropy-based Cuckoo Search Optimization and morphological reconstruction filters to segment tumors in MR brain and breast images, providing accurate results with good immunity towards noise interference. However, applying the same parameters for both modalities is not flexible and may lead to poor results in post-processed breast images. HOS features are not applied in this method, but future work will focus on using various classification techniques along with optimization algorithms to improve the approach. The accuracy rate of the proposed method is better than FCM and PSO algorithms[75].

Mridul Chawla, et.al (2018) conducted study on "Levy Flights in Metaheuristics Optimization Algorithms – A Review" The use of Levy flight (LF) as a search mechanism in metaheuristic optimization algorithms (MOA) is increasing due to its superior or equivalent results compared to non-LF counterparts. LF-based algorithms are advantageous in situations where no prior information is available, and the targets are challenging to ascertain with scarce distribution. This article aims to acquaint readers with the applicability of LF in recent optimization algorithms and their related properties. The study examines the underlying principle of LF and its use in diverse biological, chemical, and physical phenomena[76].

G. Sandhya, et.al (2017) conducted study on "Multilevel Thresholding Method Based on Electromagnetism for Accurate Brain MRI Segmentation to Detect White Matter, Gray Matter, and CSF" This work presents a Multilevel Thresholding (MT) method for accurate brain MRI segmentation, based on Electromagnetism-Like optimization algorithm and Otsu and Kapur objective functions. The approach uses skull stripping and anisotropic diffusion filter in preprocessing, and segments the image into three tissues - White Matter (WM), Gray Matter (GM), and CSF. The proposed method outperforms existing segmentation methods such as K-means, fuzzy C-means, OTSU MT, Particle Swarm Optimization (PSO), Bacterial Foraging Algorithm (BFA), Genetic Algorithm (GA), and Fuzzy Local Gaussian Mixture Model (FLGMM) in terms of sensitivity, specificity, and segmentation accuracy[82].

Mohammad Hamed Mozaffari, et.al (2017) conducted study on "Multilevel Thresholding Segmentation of T2 weighted Brain MRI images using Convergent Heterogeneous Particle Swarm Optimization" This paper proposes a new image thresholding segmentation approach using the Convergent Heterogeneous Particle Swarm Optimization algorithm. The algorithm divides the swarm into subswarms, allowing for better exploitation and exploration. The proposed method is demonstrated for medical image thresholding segmentation using Otsu and Kapur techniques as objective functions, and is shown to outperform existing methods in terms of accuracy, computation time, and stable results[83].

Shouvik Chakraborty, et.al (2017) conducted study on “Modified cuckoo search algorithm in microscopic image segmentation of hippocampus” The paper proposes a novel method for cell segmentation and identification in light microscope images of rats' hippocampus, based on cuckoo search algorithm incorporating McCulloch's method for levy flight generation. The proposed approach is evaluated using Otsu's method, Kapur entropy and Tsallis entropy as objective functions for segmentation with experiments validated by different metrics. Results show that the proposed method achieves accurate segmentation and identification of cells and requires the least computational time compared to other segmentation methods. The Tsallis entropy method with optimized multi-threshold levels achieved superior performance in terms of PSNR[84].

Mansouri Fatimaezzahra, et.al (2017) presented stuydy on “A combined cuckoo search algorithm and genetic algorithm for parameter optimization in computer vision” This paper presents an approach to automate the process of parameter optimization for image processing, machine learning, and pattern recognition systems using metaheuristics. The proposed method combines the Cuckoo Search Algorithm (CSA) with Genetic Operators (GO) to discretize the parameter space and optimize parameters automatically. The paper demonstrates the effectiveness of the proposed method through experiments on real examples of quality control applications and comparison with other metaheuristic-based approaches such as PSO, GA, and ACO[85].

Ms.Anuja.S.Joshi, et.al (2017) conducted study on “Cuckoo Search Optimization- A Review” The Cuckoo Search algorithm is a nature-inspired metaheuristic optimization algorithm based on brood parasitism. However, the constant parameters of the algorithm decrease its efficiency. To address this issue, a proper strategy for tuning the parameters of the algorithm is necessary. The article explains the fascinating behaviour of cuckoo birds and their aggressive reproduction strategy, such as laying their eggs in host bird nests and removing other eggs to increase the hatching probability of their own[86].

Molka dhieb, Mondher frikha, et.al (2016) conducted study on “A Multilevel Thresholding Algorithm for Image Segmentation Based on Particle Swarm Optimization” This paper proposes a new multilevel thresholding method based on particle swarm optimization (PSO) algorithm to maximize Kapur and Otsu objective functions. The method employs discriminate analysis using

Kapur and Otsu methods to improve the effectiveness of thresholding techniques. The proposed approach is shown to perform better than existing methods in segmenting both grey level images and MRI scans[90].

Shilpa Suresh, et.al (2016) study focused on"An efficient cuckoo search algorithm based multilevel thresholding for segmentation of satellite images using different objective functions" The paper proposes a computationally efficient satellite image segmentation algorithm, called CS McCulloch, which incorporates McCulloch's method for Levy flight generation in the Cuckoo Search algorithm. The impact of Mantegna's method for Levy flight generation in the CS algorithm is also investigated. The proposed algorithm is compared with other bio-inspired algorithms using objective functions such as Otsu's method, Kapur entropy, and Tsallis entropy. Experimental results show that the proposed algorithm is the most promising and computationally efficient for segmenting satellite images, with a stable global optimum threshold. The results encourage related research in computer vision, remote sensing, and image processing applications[91].

P. Mohapatra a, et.al (2015) conducted study on "An improved cuckoo search based extreme learning machine for medical data classification" The paper proposes an improved cuckoo search based extreme learning machine (ICSELM) for binary medical dataset classification. ICSELM uses an evolutionary algorithm, improved cuckoo search (ICS), to pre-train the extreme learning machine (ELM) by selecting input weights and hidden biases to make the model more stable. The performance of ICSELM is evaluated using four benchmark datasets, and its results are compared with ELM, on-line sequential ELM, CSELM, multi-layered perceptron, MLPICS, RBFNN, RBFNNCS, and RBFNNICS. The results demonstrate that ICSELM outperforms other models based on several performance evaluation measures, including accuracy, sensitivity, specificity, Gmean, F-score, and area under the ROC curve[95].

E. Ben George, et.al (2015) conducted study on "Brain Tumor Segmentation using Cuckoo Search Optimization for Magnetic Resonance Images" This paper discusses the application of the cuckoo search algorithm for brain tumor segmentation from MRI scans. It is challenging to differentiate tumor-like diseases from brain tissues due to the complexity of the brain structure. The proposed diagnostic system using the CS algorithm assists radiologists to detect the presence or absence of tumors by analyzing MR images. The study examines the search mechanisms of the CS algorithm and compares the results with other commonly used optimization algorithms. The proposed system is expected to assist radiologists in analyzing MR images and making accurate diagnoses[96].

S. Manikandan, et.al (2014) conducted study on"Multilevel thresholding for segmentation of medical brain images using real coded genetic algorithm" This paper presents a new approach for medical brain image segmentation using a real coded genetic algorithm with Simulated Binary Crossover (SBX) based multilevel thresholding. The proposed method achieves better performance than existing algorithms such as Nelder-Mead simplex, PSO, BF and ABF by maximizing entropy. The statistical performances of 100 independent runs show that the proposed approach consistently outperforms previously reported methods[98].

Ashish Kumar Bhandari, et.al (2014) conducted study on "Cuckoo search algorithm and wind driven optimization based study of satellite image segmentation for multilevel thresholding using Kapur's entropy" This article discusses the use of swarm-intelligence-based global optimization algorithms, namely the cuckoo search algorithm and wind-driven optimization, for multilevel thresholding in image segmentation. The algorithms optimize the objective function of entropy and select optimal threshold values for a meaningful segmentation. The proposed approach is compared with other methods and is shown to accurately and efficiently perform multilevel thresholding on standard satellite images[99].

Saeed Balochian, et.al (2013) conducted study on "A Combined Cuckoo Search Algorithm and Genetic Algorithm for Parameter Optimization in Computer Vision" This paper addresses the challenge of parameter tuning in vision systems and proposes an automated approach using metaheuristic algorithms. The approach combines CSA with Genetic Operators (GO) and adapts the parameter space. The authors perform experiments on real examples of quality control applications and compare their method to other metaheuristic-based approaches such as PSO, GA, and ACO. Results show that the proposed CSA-GO method is effective in optimizing parameters automatically with improved accuracy and reduced time constraint[102].

Sanjay Agrawal, et.al (2013) conducted study on "Tsallis entropy based optimal multilevel thresholding using cuckoo search algorithm" The paper proposes a method for obtaining optimal thresholds for multi-level image thresholding using the Tsallis entropy maximization with the cuckoo search algorithm. The proposed method is tested on a standard set of images and compared with other optimization algorithms. Results show that the proposed method performs well both qualitatively and quantitatively, with promising results in terms of CPU time and objective function values[103].

Xin-She Yang, et.al (2010) conducted study on “Test Problems in Optimization” This paper discusses the importance of test functions in validating and comparing optimization algorithms. The authors emphasize the need for a diverse set of test functions to ensure that new algorithms can efficiently solve different types of optimization problems. They provide a selected list of test problems for unconstrained optimization to be used as a standard reference for researchers[110].

Xin-She Yang, et.al (2009) conducted study on “Cuckoo Search via Levy Flights” The paper proposes a new meta-heuristic algorithm, called Cuckoo Search, based on the behavior of some cuckoo species and the Levy flight behavior of some birds and fruit flies. The algorithm is validated against test functions and compared with genetic algorithms and particle swarm optimization, demonstrating its superior performance. The results are discussed, and suggestions for further research are provided[113].

2.5 FEATURE EXTRACTION OF THE BRAIN MRI IMAGE

Feature extraction is a part of the dimensionality reduction process, in which, an initial set of the raw data is divided and reduced to more manageable groups. So when you want to process it will be easier. The most important characteristic of these large data sets is that they have a large number of variables. These variables require a lot of computing resources to process. So Feature extraction helps to get the best feature from those big data sets by selecting and combining variables into features, thus, effectively reducing the amount of data. These features are easy to process, but still able to describe the actual data set with accuracy and originality. Feature extraction is an important step in the analysis of brain MRI images, as it involves identifying and quantifying relevant features from the image data that can be used to aid in the diagnosis and treatment of neurological disorders. Feature extraction is the process of extracting important and relevant information or features from raw data that can be used for analysis or classification. There are various feature extraction methods available; like Discrete Wavelet Transform, Gray Level Co-occurance Matrix, Local Binary Pattern, Histogram of Oriented Gradients, etc. DWT is a mathematical technique used to analyze signals and images. It is a type of transform that breaks down a signal into its frequency components at different scales, allowing for the detection of patterns and features that may not be easily visible in the original signal. In image processing, DWT is often used for feature extraction by decomposing an image into its sub-bands, which represent different scales and orientations of features in the image. GLCM is a method used in image processing to extract texture features. It works by calculating the co-occurrence matrix of pixel values in an image, which represents the spatial relationship between pairs of pixels with specific intensity values. From this matrix, statistical measures such as contrast, entropy, and homogeneity can be calculated, which can be used as features for classification and recognition tasks. LBP is a texture descriptor used for feature extraction in computer vision. It works by comparing the intensity of each pixel in an image with its surrounding pixels, and encoding the results as binary patterns. These patterns can then be used as features for tasks such as facial recognition, object detection, and texture classification. HOG is a method used for feature extraction and object detection in computer vision. It works by calculating the gradient orientation of pixels in an image, and then dividing the image into small cells and computing histograms of gradient orientations within each cell. These histograms can then be used as features for detecting objects in images. PCA is a statistical technique used for feature extraction and dimensionality reduction. It works by identifying the most important features in a dataset, and transforming the data into a new coordinate system that captures the maximum amount of variance. The resulting transformed features can then be used for tasks such as clustering, classification, and visualization.

2.5.1 COMPARATIVE ANALYSIS FOR FEATURE EXTRACTION TECHNIQUES

Survey of different Feature Extraction Techniques of the MRI Brain Image are as follows:

Chiranji Lal Chowdhary,et.al (2020) conducted study on “Segmentation and Feature Extraction in Medical Imaging: A Systematic Review” The paper provides an overview of medical imaging, which is used for medical diagnosis, analyzing illnesses and generating datasets of normal and abnormal images. Medical imaging is divided into two types: visible-light and invisible-light imaging, with the latter requiring interpretation by a radiologist. The paper focuses on tumor detection through mammograms or magnetic resonance imaging, and presents a survey of various segmentation and feature extraction methods used in medical imaging[50].

Pratima Purushottam Gumaste,et.al (2020) conducted study on “A Hybrid Method for Brain Tumor Detection using Advanced Textural Feature Extraction” This paper discusses the challenges faced in developing algorithms for brain tumor segmentation due to the complexities of brain images. Magnetic Resonance Imaging (MRI) has become an important diagnostic tool in medical imaging. The objective of the paper is to develop an algorithm for feature extraction from the right and left hemispheres of the brain, using advanced higher-order statistical features. Tumor areas are extracted using Support Vector Machine from statistical features, facilitating the localization of tumor tissues based on a single-spectral structural MRI image [51].

S. Vani Kumari, (2020) conducted study on "Analysis on Various Feature Extraction Methods for Medical Image Classification" This paper discusses the use of soft computing techniques like Neural Networks, Fuzzy Logic, Support Vector Machines, and Genetic Algorithms for medical image processing. The focus of the study is on finding the best feature extraction method for classifying medical images. Local Binary Patterns, Gray-Level-Run-Length-Matrix, Completed Local Binary Patterns, Gray-Level Co-occurrence Matrix, and Local Tetra Patterns are considered. Two classifiers, MLPBPN and SVM, are used to evaluate the efficiency of these feature extraction techniques on five different medical image datasets. The results show that the GLCM method is the best compared to the other four feature extraction methods for medical image classification [52].

Wadhah Ayadi,et.al (2019) conducted study on "A hybrid feature extraction approach for brain MRI classification based on Bag-of-words" The paper discusses various techniques for classifying human brain MR images into normal/abnormal categories using computer-aided diagnosis. A new scheme using Discrete Wavelet Transform (DWT) and Bag-of-Words (BoW) is proposed, which is validated on three datasets using k-fold stratified Cross Validation (CV) technique. The results show accuracies of 100%, 100%, and 99.61% for the three datasets with an overall computation time of 0.027 s per MR image. The proposed scheme is compared with other works, demonstrating its efficiency and robustness[65].

Aqidatul Izza Poernama, et.al (2019) study focused on "Feature Extraction and Feature Selection Methods in Classification of Brain MRI Images: A Review" This paper discusses the importance of early detection of brain tumors through MRI and examines 9 feature extraction and 3 feature selection methods for classification of brain MRI images. Local Binary Pattern combined with GLRL, ZM, PHOG, and GLCM is found to be the best feature extraction method for BRATS dataset with a classification accuracy of 97.1%. GLDM and GA are the best combinations of feature extraction and selection method for clinical datasets with a classification accuracy of 98%.

The advantages and disadvantages of each method are explored and presented in a table for easy reference[90].

Taner Çevik, et.al (2018) conducted study on "A Comprehensive Performance Analysis of GLCM-DWT based Classification on Fingerprint Identification" The paper investigates the performance of Gray Level Co-occurrence Matrix based classification on Discrete Wavelet Transform (DWT)-compressed fingerprint images. GLCM is a statistical textual feature extraction method for texture analysis, and DWT-based compression is popular for reducing image size. Simulation results show that classification performance sharply decreases with the increase of DWT-compression level. The study identifies eight of the most prominent Haralick features that affect the accuracy performance of the classification, instead of utilizing all of them. The findings suggest that GLCM-based classification can be applied efficiently on DWT-compressed fingerprint images with appropriate levels of compression and feature selection[77].

Mohammed Khalila ,et.al (2018) conducted study on "Performance evaluation of feature extraction techniques in MR-Brain image classification system" The paper proposes a MR-brain image classification system that utilizes three feature extraction techniques, GLCM, LBP, and HOG, followed by a k-NN classifier and a fusion operator to classify a given MR-brain image as normal or abnormal. The system is evaluated using two benchmark MR image datasets, Dataset-66 and Dataset-160, with a cross-validation scheme to improve generalization capability. The simulation results are compared with existing methods, and the proposed system shows promising results in terms of classification accuracy[78].

Sigit Widiyanto, et.al (2018) conducted study on "Texture Feature Extraction Based On GLCM and DWT for Beef Tenderness Classification" This paper proposes a method to extract beef texture as the basic features for beef classification, as tenderness cannot be visually assessed. The method uses statistical analysis of Gray Level Co-occurrence Matrix (GLCM) and domain frequencies Discrete Wavelet Transform (DWT) for texture feature extraction. The correlation test shows significant correlations for certain GLCM and DWT features. The proposed method achieves a 100% accuracy, precision, and recall for the classification of beef using the Support Vector Machine method with a polynomial kernel [27].

Ahmad Chaddad, et.al (2015) conducted study on "Automated Feature Extraction in Brain Tumor by Magnetic Resonance Imaging Using Gaussian Mixture Models" The paper proposes a novel method for Glioblastoma (GBM) feature extraction based on Gaussian mixture model (GMM) features using MRI. The proposed method detects a pathologic area using multithresholding segmentation with morphological operations of MR images and employs multiclassifier techniques to discriminate GBM and normal tissue. Comparative study using principal component analysis (PCA) and wavelet-based features shows that GMM features demonstrate the best performance. The proposed method achieves promising experimental results with accuracy performance of 97.05% (AUC = 92.73%) for T1-WI, 97.05% (AUC = 91.70%) for T2-WI, and 94.11% (AUC = 95.85%) for FLAIR mode, showing potential for enhancing the characteristics of heterogeneity and early treatment of GBM [97].

D. Jude Hemanth, et.al (2012) conducted study on "Image Pre-processing and Feature Extraction Techniques for Magnetic Resonance Brain Image Analysis" This paper emphasizes the importance of image pre-processing and feature extraction techniques in achieving high accuracy and convergence rates for image-based applications. The paper specifically highlights their significance in Magnetic Resonance (MR) brain image classification and segmentation. The paper presents developed pre-processing techniques to remove the skull portion surrounding the brain tissues and texture-based feature extraction techniques. The experimental results show promising results for the proposed approaches, analyzed in terms of segmentation efficiency for pre-processing and distance measure for feature extraction techniques, and the convergence rate of these approaches is also discussed[106].

Leen-Kiat Soh,et.al (1999) study focused on "Texture Analysis of SAR Sea Ice Imagery Using Gray Level Co-Occurrence Matrices" The paper discusses a preliminary study on using gray-level co-occurrence matrices (GLCM) to map sea ice texture patterns with 100-m ERS-1 synthetic aperture radar (SAR) imagery. The study aims to determine the best parameter values and representations for mapping sea ice texture. The experiments conducted examine the effects of textural descriptors such as entropy and the quantization levels, displacement, and orientation values of GLCM. The paper shows that a complete gray-level representation is not necessary for texture mapping, an eight-level quantization representation is not desirable, and the displacement factor is more important than orientation. The paper also evaluates three GLCM implementations and concludes that using a range of displacement values is the best method to represent sea ice texture. The findings provide insights into the best parameters for SAR sea ice texture analysis using GLCM[116].

Robert M,et.al (1973) conducted study on “Textural Features for Image Classification” This paper discusses the importance of texture as a characteristic for identifying objects or regions of interest in different types of images. The authors propose easily computable textural features based on gray-tone spatial dependencies and apply them to three different types of image data: photomicrographs of sandstones, aerial photographs of land-use categories, and satellite imagery of land-use categories. The authors use two decision rules and divide the data sets into training and test sets. The results show an identification accuracy of 89%, 82%, and 83% for photomicrographs, aerial photographic imagery, and satellite imagery, respectively, suggesting that these text [122].

2.6 FEATURE CLASSIFICATION OF THE BRAIN MRI IMAGE

A pattern recognition technique that is used to categorize a huge number of data into different classes.Feature classification is the process of categorizing data into different classes based on their extracted features. In the context of image processing, it involves extracting a set of features from an image, and then using a classifier algorithm to categorize the image into different classes based on these features. The objective is to identify patterns and relationships between different features that can be used to distinguish one class from another. Feature classification is commonly used in various applications, including object recognition, facial recognition, medical image analysis, and many more. There are several types of feature classification methods used; like; Support Vector Machine, Random Forest, K – Nearest Neighbor, Artificial Neural Network, Decision Trees, etc. SVM is a supervised learning algorithm used for classification and regression analysis. It works by finding the best hyperplane that separates the data points of different classes. SVM is particularly effective in dealing with high-dimensional data. Random Forest is an ensemble learning method that creates multiple decision trees and combines their results to make a final prediction. It is effective in dealing with noisy and high-dimensional data. KNN is a non-parametric algorithm used for classification and regression analysis. It works by finding the K nearest neighbors to a given data point and assigning the class label based on the majority vote of the K neighbors. ANN is a machine learning model inspired by the structure and function of the human brain. It consists of multiple layers of interconnected nodes and can be used for classification, regression, and clustering tasks. Decision trees are a type of supervised learning algorithm used for classification and regression analysis. They work by recursively splitting the data into subsets based on the most informative feature, until the subsets are homogeneous in terms of the target variable. Naive Bayes is a probabilistic algorithm based on Bayes' theorem. It works by assuming that the features are independent of each other, and calculates the probability of each class given the features. Each of these methods has its own strengths and weaknesses, and the choice of method depends on the specific problem and data at hand.

2.6.1 COMPARATIVE ANALYSIS FOR FEATURE CLASSIFICATION TECHNIQUES

Survey of different Feature Classification Techniques of the MRI Brain Image are as follows:

P sharma, et.al (2022) conducted study on "Efcient Detection and Classifcation of Brain Tumor using Kernel based SVM for MRI" This article highlights the challenges in automatic segmentation and classification of brain tumors using MRI. The proposed methodology includes pre-processing, segmentation, feature extraction, selection, and classification using machine learning models. The study uses the Harris hawks optimization algorithm for feature selection and KSVM-SSD for classification. The results of the study show that the proposed KSVM-SSD model outperforms existing methods in terms of precision, accuracy, recall, and F1 score. The accuracy of the proposed model tested on BRATS datasets is reported as 99.2%, 99.36%, and 99.15% for 2018, 2019, and 2020 datasets, respectively, demonstrating superior performance in tumor detection and classification[28].

D. Rammurthy, et.al (2022) conducted study on "Whale Harris hawks optimization based deep learning classifier for brain tumor detection using MRI images" This paper presents a Whale Harris Hawks optimization (WHHO) based technique for brain tumor detection using MR images. The proposed technique uses cellular automata and rough set theory for segmentation and features extraction, which include tumor size, Local Optical Oriented Pattern (LOOP), Mean, Variance, and Kurtosis. Deep Convolutional Neural Network (DeepCNN) is used for brain tumor detection, with training performed using proposed WHHO. The proposed technique achieved a maximal accuracy of 0.816, maximal specificity of 0.791, and maximal sensitivity of 0.974, outperforming other methods. The proposed technique can assist radiologists in detecting brain tumors with high precision[11].

Ahmet Çinar, et.al (2020) conducted study on "Detection of tumors on brain MRI images using the hybrid convolutional neural network architecture" The accurate and early diagnosis of brain tumors is crucial for effective treatment. Computer-aided systems can facilitate tumor detection and prevent errors in traditional methods. This study aimed to use MRI images to diagnose brain tumors using deep learning networks, specifically CNN models. The Resnet50 architecture was used as the base, with 8 new layers added and the last 5 layers removed. The model achieved an accuracy of 97.2%, and other models such as Alexnet, Densenet201, InceptionV3, and Googlenet were also tested. The study concluded that the developed method was effective and could be used in computer-aided systems for brain tumor detection[53].

P.M. Siva Raja, et.al (2020) conducted study on "Brain tumor classification using a hybrid deep autoencoder with Bayesian fuzzy clustering-based segmentation approach" Brain tumor detection and segmentation in medical image processing can be challenging and time-consuming. This paper presents a brain tumor classification method using a hybrid deep autoencoder with a Bayesian fuzzy clustering-based segmentation approach. The pre-processing stage involves denoising using a non-local mean filter, followed by segmentation using the BFC approach. Robust features such as information-theoretic measures, scattering transform, and wavelet packet Tsallis entropy are used for feature extraction. A hybrid scheme of DAE with JOA and softmax regression is used for tumor classification. Simulation results using the BRATS 2015 database showed that the proposed approach achieved high classification accuracy of 98.5%, outperforming other state-of-the-art methods[54].

Nimmisha Shajihan, et.al (2020) conducted study on "Classification of stages of Diabetic Retinopathy using Deep Learning" Diabetes mellitus is a chronic disease that affects many aged people, and it can lead to diabetic retinopathy, which damages the retina and can cause blindness. Early detection of this condition can be challenging for ophthalmologists using traditional methods. This paper reviews the use of a Deep Learning approach with convolutional neural networks to accurately detect diabetic retinopathy stages and severity with Fundus photography, which is a less expensive and time-consuming method. This method can potentially save people from blindness and improve the efficiency of diabetic retinopathy detection[55].

S. Anandh, et.al (2020) conducted study on "new efficient knn classifier to detect abdominal aortic aneurysms using digital image processing" Abdominal Aortic Aneurysms (AAA) is a swelling disorder that is evaluated using Magnetic Resonance Imaging and treated with Endovascular Aneurysm Repair (EVAR). The classification of AAA images is critical, but it can be a tedious and challenging task for radiologists and medical specialists. To overcome this issue, a PC-supported method using KNN and GWT was proposed to enhance accuracy and reduce complications. The proposed method was tested on MATLAB with an accuracy of 95.24%, clarity of 93.4%, and sensitivity of 94.7%. The results show an improvement in distinguishing normal and abnormal layers of cells in AAA images[56].

Javaria Amin, et.al (2019) conducted study on "Brain tumor detection using statistical and machine learning method" The early detection of brain tumors is crucial for increasing the survival rate of patients. This study proposes an approach for detecting brain tumors in their early phases using Magnetic Resonance Imaging (MRI). The proposed approach is evaluated using PSNR, MSE, and SSIM yielding promising results. The segmentation results have been evaluated at the pixels level, individual features, and fused features. The approach achieved high precision on a local dataset and on a multimodal brain tumor segmentation challenge dataset. Overall, the proposed approach is effective and has the potential to contribute to the early detection of brain tumors[67].

Raheleh Hashemzehi, et.al (2019) conducted study on "Detection of brain tumors from MRI images base on deep learning using hybrid model CNN and NADE" The paper discusses the use of magnetic resonance imaging (MRI) for brain tumor detection and proposes a new hybrid paradigm consisting of a neural autoregressive distribution estimation (NADE) and a convolutional neural network (CNN) for classification. The model is trained on MRI images and tested with 3064 T1-weighted contrast-enhanced images with three types of brain tumors. The results show that the hybrid CNN-NADE has a high classification performance[57].

2.7 CONCLUSION

The literature survey of different stages were described. MRI Brain Image is used for research work. Different filters likes; wiener filter, anisotropic filter, median filter, non local means filter and combined filters are compared and used for further processing. The different multithresholding algorithms of the MRI Brain Images are compared and found that Cuckoo Search Algorithm gives better result, which is used for next stage. Different Feature Extraction methods have been referred and found Discrete Wavelet Transform is effective feature extraction method for Brain Tumor

Detection. So feature extraction with Discrete Wavelet Transform is selected for furture processing. For Classficiation Support Vector Machine has been implemented.