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DESIGN AND IMPLEMENTATION OF BRAIN TUMOR DETECTION USING HYBRID MACHINE LEARNING

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Abstract: The brain tumors detection is crucial for early diagnosis and treatment, which can significantly improve patient outcomes. This paper presents a novel approach for brain tumor detection using a hybrid machine learning model that combines Support Vector Machine (SVM) and Random Forest (RF). The SVM is employed for classification, leveraging its ability to find the optimal boundary for tumor classification in the feature space. On the other hand, the Random Forest algorithm is used to enhance the model's accuracy by handling a large dataset and extracting relevant features. The hybrid SVM+RF model is trained on medical imaging data, such as MRI scans, to identify and classify tumor regions as benign or malignant. The performance of the proposed system is evaluated based on metrics such as accuracy, precision, recall and F1-score, demonstrating superior classification performance compared to traditional machine learning methods. This approach provides an efficient, scalable and reliable solution for automated brain tumor detection, offering potential clinical applications in real-time diagnostics and decision-making processes.

Keywords: Brain Tumors Detection, Hybrid Machine Learning Model, Support Vector Machine (SVM), Random Forest (RF

I. INTRODUCTION

Brain tumors represent one of the most critical challenges in modern healthcare due to their complex nature and the significant impact they have on patients' lives. Timely detection and accurate diagnosis of brain tumors are essential for effective treatment planning and patient survival. Traditionally, brain tumor diagnosis relies heavily on manual inspection of medical imaging data, such as MRI and CT scans, by radiologists. However, this process can be time-consuming, prone to human error and subject to inter-observer variability. As the volume of medical images continues to increase, automated systems capable of reliably detecting brain tumors have become more essential in clinical settings.

Machine learning (ML) and Random Forests (RF) have emerged as promising solutions for automating the process of brain tumor detection. These technologies allow for the development of models that can learn from large amounts of data and make predictions based on patterns that may be difficult for human experts to identify. Among the various machine learning techniques, classification algorithms play a vital role in tumor detection. Support Vector Machines (SVM) and Random Forests (RF) are two of the most widely used classification algorithms due to their robustness and high performance in medical image analysis. However, the use of these models individually can sometimes result in limitations in terms of accuracy, generalization and computational efficiency.

To address these challenges, hybrid machine learning techniques have gained attention as they combine the strengths of multiple algorithms to improve overall performance. This paper proposes a hybrid machine learning approach that integrates the SVM and RF classifiers for the task of brain tumor detection. By combining the discriminative power of SVM with the ensemble learning capabilities of RF, this hybrid model is designed to enhance both the accuracy and reliability of tumor classification. The hybrid model aims to address the limitations of each individual classifier by leveraging their complementary strengths.

The proposed hybrid SVM+RF model is trained on medical imaging data, particularly MRI scans, which are widely used in the diagnosis of brain tumors. MRI provides high-resolution images of the brain, making it an invaluable tool for detecting abnormalities such as tumors. By combining feature extraction with the power of hybrid machine learning, the system can identify and classify brain tumors more effectively than traditional methods.

This research aims to contribute to the development of more efficient and accurate systems for brain tumor detection, which can significantly reduce the time required for diagnosis and improve clinical decision-making. The hybrid approach proposed in this study is expected to outperform traditional machine learning models, providing a more robust solution to the challenge of automated brain tumor detection. Through extensive experimentation and performance evaluation, the paper demonstrates the efficacy of the SVM+RF hybrid model in detecting and classifying brain tumors, paving the way for future advancements in medical imaging.

II. LITERATURE SURVEY

G. Hemanth, M. Janardhan and L. Sujihelen et al. Nowadays, brain tumor detection has turned upas a general causality in the realm of health care. Brain tumor can be denoted as a malformed mass of tissue wherein the cells multiply abruptly and ceaselessly, that is there is no control over the growth of the cells. The process of Image segmentation is adopted for extracting abnormal tumor region within the brain. In the MRI (magnetic resonance image), segmentation of brain tissue holds very significant in order to identify the presence of outlines concerning the brain tumor. There is abundance of hidden information in stored in the Health care sector. With appropriate use of accurate data mining classification techniques, early prediction of any disease can be effectively performed. In the medical field, the techniques of ML (machine learning) and Data mining holds a significant stand. Majority of which is adopted effectively. The research examines list of risk factors that are being traced out in brain tumor surveillance systems. Also the method proposed assures to be highly efficient and precise for brain tumor detection, classification and segmentation. To achieve this precise automatic or semi-automatic methods are needed. The research proposes an automatic segmentation method that relies upon CNN (Convolution Neural Networks), determining small 3 × 3 kernels. By incorporating this single technique, segmentation and classification is accomplished. CNN (a ML technique) from NN (Neural Networks)wherein it has layer based for results classification. Various levels involved in the proposed mechanisms are: 1. Data collection, 2. Pre-processing, 3. Average filtering, 4. segmentation, 5. feature extraction, 6. CNN via classification and identification. By utilizing the DM (data mining) techniques, significant relations and patterns from the data can be extracted. The techniques of ML (machine learning) and Data mining are being effectively employed for brain tumor detection and prevention at an early stage [1].

W. El Elhola and K. Bozed et al. Tumors of the brain are one of the most prevalent and severe diseases, due to high mortality rate. Thus, The categorization of brain tumors is crucial for accurate clinical diagnosis and treatment. The aim of this research is to develop a prototype system for detecting brain tumors using the gradient boost algorithm and deep learning model in order to analysis the efficiency. In our proposed method was tested on a data set of 3000 MRI images, and we divided them into (80%)for training and (20%)testing, and then based on the idea of transfer learning and the use of deep convolutional neural networks that have been pre-trained to extract deep features from brain MRI.For the classification stage, At first we applied the concept of deep learning, that is, we used CNN as a classifier and as a feature extractor, and then use same the features with gradient boosting (Gradient Boost, XGBoost, LightGBM, CatBoost) algorithms as a classifier. And for the purpose of analyzing the performance of these algorithms, we have implemented other machine learning algorithms (LogisticRegression, Support Vector Machines, Neural network, Adaptive Boosting, Random Forest, Decision Tree, K-Nearest Neighbors) and finally we have compared all the classifiers.the results showed that most of the proposed detection models, whether independent (CNN) or composite models , have high performance in detecting brain tumor and this is one of our goals in this study. Our main goal is to analyze the performance of Gradient Boosting algorithms. Whereas, the Gradient Boosting algorithm was the least effective in classifying with an accuracy of 0.952 and a time of (17m and 3s), followed by LightGBM with an accuracy of 0.979 and a time of (8m and 51s), and CatBoost with an accuracy of 0.974 and a time of(20m and40s), while the XGBoost algorithm had the best performance in this category, with an accuracy of 0.981 but with a larger time of (23m and 3s) [2].

B. R. Sree et al. Nowadays, Brain tumor detection has turned into a casualty in the health care sector. A tumor is a swelling or a morbid enlargement caused by an overabundant growth of cells and their division. Generally, cells grow and divide to make new cells controlled. A tumor is not the same as cancer; tumors may be malignant or premalignant. The usage of Machine Learning holds a significant stand in the medical field. Hence, Machine Learning techniques are being used efficiently to detect brain tumor and prevent it at an early stage [3].

J. Ramasamy, R. Doshi and K. K. Hiran et al. Computer-aided diagnostics play a big part in figuring out what's wrong with MRI images, which helps the radiologist. As among the most prevalent and incurable cancers, brain tumors can lead to a short average lifespan in their most severe form. If the brain tumor is found and detected early, the patient may have a better chance of survival. When using medical imaging, detecting a brain tumor is notoriously challenging. Factors such as the tumor's size, shape, and location might vary from patient to patient. A tumor's location in the brain makes it a difficult task to identify, therefore knowing these details are critical. It's possible that some people have tumors of high glioma type, while others have tumors of low glioma type. As a result, it is vitally important to learn how to interpret medical imaging to identify a malignant tumor. Tumor and non-tumor images in medical imaging can be differentiated using a variety of machine learning methods. In this work we have used HOG to extract features from the medical data of patients with cancer tumors and then used them to classify using machine learning algorithms [4].

B. Shetty, R. Fernandes, A. P. Rodrigues and P. Vijaya et al. When abnormal cells develop within the brain, a tumor is created. Depending on the size of the tumor and the section of the brain affected, symptoms from all forms of brain tumors might differ. Where symptoms are present, they may include vomiting, headaches, seizures, eyesight issues, and mental changes. Other signs might include the inability to speak or walk, feelings, or unconsciousness. A combination of surgery, radiation therapy, and chemotherapy may be used as treatment. The proposed work developed a binary classifier to detect MRI based brain tumors. The detection of MRI-based brain tumors will be covered in this research paper utilizing the machine learning model and convolutional neural network. An open dataset was used in this study. The dataset consists of 1500 brain MRI images with tumors and 1500 brain MRI images without tumors. The findings indicate that CNN model obtained better accuracy of 98.21% than the machine learning algorithms [5].

III. METHODOLOGY

The proposed methodology for brain tumor detection using a hybrid machine learning model (SVM+RF) follows a systematic approach. The entire process involves several stages, including data collection, preprocessing, feature extraction, classification and prediction. The aim is to develop an efficient system capable of detecting and classifying brain tumors from medical imaging data, such as MRI scans, using machine learning techniques.

High-quality MRI brain scan images, which serve as the primary dataset. These images are sourced from publicly available medical imaging databases, ensuring diversity in terms of patient demographics, tumor types, and image quality. Once collected, the images undergo preprocessing to remove noise, standardize the image sizes and enhance important features. Techniques such as image denoising, normalization and contrast enhancement are applied to improve the clarity of the MRI scans. Additionally, pixel-based segmentation is employed to separate the tumor region from the healthy brain tissue. This segmentation process uses pixel intensity values and clustering techniques to identify the tumor area, which forms the foundation for subsequent feature extraction.

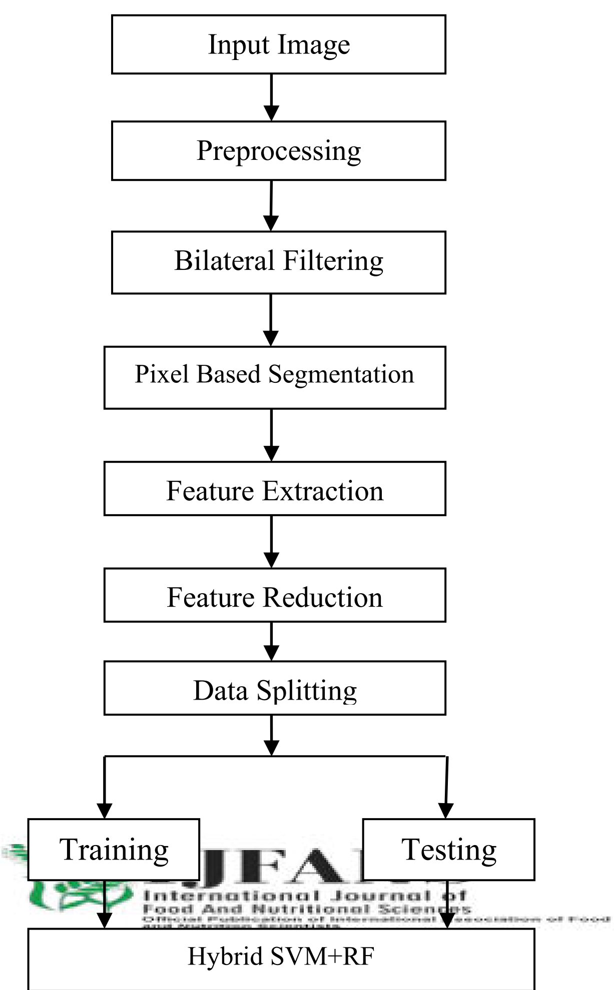

Fig. 1: Block Diagram

The pixel-based segmentation is a crucial step in isolating the tumor region from the rest of the brain. In this approach, each pixel in the MRI image is evaluated based on its intensity value, which indicates whether it belongs to the tumor or the surrounding healthy tissue. A thresholding method or clustering algorithms like k-means clustering can be applied to segment the tumor region. In addition, techniques like edge detection and morphological operations may be used to refine the segmented region, ensuring that the tumor boundaries are accurately identified. This segmentation process is critical as it provides the exact tumor location, which is vital for further analysis and classification.

Once the tumor region is segmented, relevant features are extracted to provide useful information for classification. These features typically include texture, shape, and intensity-based characteristics of the tumor area. For texture analysis, statistical methods such as Gray Level Co-occurrence Matrix (GLCM) or Local Binary Patterns (LBP) are used to capture patterns in pixel intensity variation within the segmented tumor region. Shape features, including the area, perimeter and compactness of the tumor, are also extracted to help differentiate between benign and malignant tumors. Intensity-based features are derived from the pixel intensity values within the tumor region, providing additional insights into the tumor's characteristics. These extracted features serve as input for the hybrid machine learning model.

The next step is the classification of the tumor based on the extracted features using the hybrid SVM+RF model. The Support Vector Machine (SVM) is employed for its ability to classify data by finding the optimal hyperplane that separates tumor classes (benign or malignant). The Random Forest (RF) algorithm, an ensemble learning method, is used to improve classification performance by combining the outputs of multiple decision trees to reduce over fitting and enhance generalization. The hybrid model first processes the feature set through both SVM and RF and the final classification decision is made based on the combined output of both classifiers. This dual-classification approach ensures higher accuracy, reduces errors and takes advantage of both the discriminative power of SVM and the robustness of RF.

In the prediction step, the trained hybrid machine learning model (SVM+RF) is applied to new, unseen MRI images for brain tumor detection. The input image undergoes the same preprocessing and pixel-based segmentation process as during training, where the tumor region is isolated from the surrounding healthy brain tissue. Once the tumor is segmented, relevant features, such as texture, shape and intensity, are extracted from the identified tumor region. These features are then fed into the hybrid model, which combines the outputs of the Support Vector Machine (SVM) and Random Forest (RF) classifiers to predict whether the tumor is benign or malignant. The model uses its learned patterns to make a final prediction and the output is presented, indicating the presence, type and severity of the brain tumor. This prediction step provides a real-time, automated solution for accurate brain tumor diagnosis, assisting clinicians in their decision-making process.

Through this proposed hybrid machine learning model integrates pixel-based segmentation with SVM+RF classification to achieve accurate and robust brain tumor detection. The pixel-based segmentation ensures precise identification of the tumor region, while the hybrid classifier improves the overall accuracy and reliability of the detection system.

IV. RESULTS

In this section performance analysis of brain tumor detection using hybrid machine learning is observed.

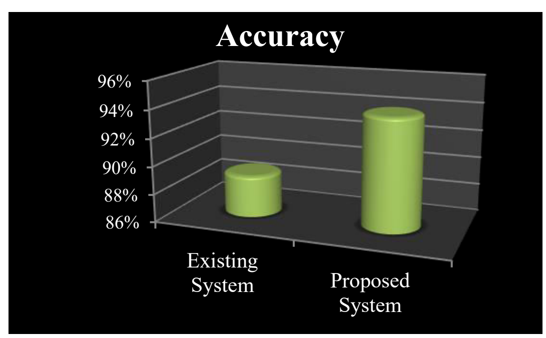

Fig. 2: Accuracy Comparison Graph

In figure 2 shows the accuracy comparison graph is observed between existing system and proposed system. The proposed system shows the high accuracy.

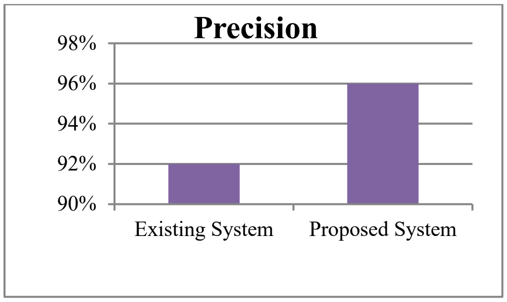

Fig. 3: Precision Comparison Graph

In figure 3 shows the precision comparison graph is observed between existing system and proposed system. The proposed system shows the better precision.

V. CONCLUSION

Hybrid machine learning model combining Support Vector Machine (SVM) and Random Forest (RF) offers a robust and effective solution for brain tumor detection. By leveraging the strengths of both classifiers, the model demonstrates superior performance in accurately identifying and classifying brain tumors from MRI scans, significantly improving diagnostic reliability and efficiency. The pixel based segmentation process ensures precise tumor localization, while the hybrid SVM+RF model effectively handles the complexity of medical imaging data to provide reliable predictions. With high evaluation metrics such as accuracy and precision, this approach shows great potential for real-time, automated brain tumor detection, ultimately supporting clinicians in making informed decisions and improving patient outcomes.

VI. REFERENCES

[1] G. Hemanth, M. Janardhan and L. Sujihelen, "Design and Implementing Brain Tumor Detection Using Machine Learning Approach," 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2019, pp. 1289-1294, doi: 10.1109/ICOEI.2019.8862553.

[2] W. El Elhola and K. Bozed, "Performance Analysis of Brain Tumor Detection Based on Gradient Boosting Machine -CNN model," 2022 IEEE 2nd International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering (MI-STA), Sabratha, Libya, 2022, pp. 544-547, doi: 10.1109/MI-STA54861.2022.9837738.

[3] B. R. Sree et al., "Brain Tumor Detection and Classification using Magnetic Resonance Imaging and Machine Learning Approaches," 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2022, pp. 1729-1734, doi: 10.1109/ICCMC 53470.2022.9754077.

[4] J. Ramasamy, R. Doshi and K. K. Hiran, "Detection of Brain Tumor in Medical Images Based on Feature Extraction by HOG and Machine Learning Algorithms," 2022 International Conference on Trends in Quantum Computing and Emerging Business Technologies (TQCEBT), Pune, India, 2022, pp. 1-5, doi: 10.1109/TQCEBT54229.2022.

[5] B. Shetty, R. Fernandes, A. P. Rodrigues and P. Vijaya, "Brain Tumor Detection using Machine Learning and Convolutional

Neural Network," 2022 International Conference on Artificial Intelligence and Data Engineering (AIDE), Karkala, India, 2022, pp. 86-91, doi: 10.1109/AIDE57180.2022.10060254.

[6] Ali Isina, Cem Direkoglu and Melike Sah, "Review of MRI-based brain tumor image segmentation using deep learning metbods", Procedia Com puter Science, vol. 102, pp. 317-324, 2016.

[7] Ayuni Fateeba Muda, Norbasbimah Mobd Saad, S. A. R. Abu Bakar, Sobri Muda and A. R. Abdullab, "Brain Lesion Segmentation Using Fuzzy C-Means on Diffusion-Weigbted Imaging", ARP Journal of Engineering and Applied Sciences, vol. 10, no. 3, pp. 1819-6608, February 2015.

[8] N. Varuna Shree and T. N. R. Kumar, "Identification and classification of brain tumor MRI images with feature extraction using DWT and probabilistic neural network" in Brain Informatics, Springer, pp. 23-30.

[9] Zhenyu Tang, Ahmad Sahar, Yap Pew-Thian and Shen Dinggang, "Multi-Atlas Segmentation of MR Tumor Brain Images Using Low-Rank Based Image Recovery", IEEE Trans Med Imaging, vol. 37, no. 10, pp. 2224-2235, 2018.

[10] Natarajan P, Krishnan. N, Natasha Sandeep Kenkre, Shraiya Nancy and Bhuvanesh Pratap Singh, "Tumor Detection using threshold operation in MRI Brain Images", IEEE International Conference on Computational Intelligence and Computing Research, 2014.

[11] N V Krishna Rao, Y HarikaDevi, N Shalini, A Harika, V Divyavani and N Manga Thayaru, "Credit Card Fraud Detection Using Spark and Machine Learning Techniques", ICACECS2020 Machine Learning Technologies and Applications, pp. 163-172, march 2021.

[12] A. A. Mozhi and W Vinu, "A comparative study of aggression between men and women kabaddi and kho-kho players", International Journal of Physiology Nutrition and Physical Education, vol. 4, no. 1, pp. 380-382, 2019.

[13] Geno Peter, Anli Sherine, Yuvaraja Teekaraman, Ramya Kuppusamy and Arun Radhakrishnan, "Design of Automated Deep Learning-based Fusion Model for Copy-Move Image Forgery Detection", Computational Intelligence and Neuroscience., vol. 2022, pp. 9, 2022.

[14] G. Gokilakrishnan, S. Ganeshkumar, H. A and M. Vigneshkumar, "A Critical Review of Production DistributionPlanning Models", 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS), pp. 2047-2051, 2021.

[15] H. A and K. Nisha, "Enhanced multicast cluster-based routing protocol for delay tolerant mobile networks", International Journal of Information and Communication Technology, vol. 7, no. 6, pp. 676, 2015.

[16] Hariprasath Manoharan, Yuvaraja Teekaraman, Ramya Kuppusamy, Arun Radhakrishnan and K Venkatachalam, "Acclimatization Of Nano Robots In

Medical Applications Using Artificial Intelligence System With Data Transfer Approach", Wireless Communications And Mobile Computing., vol. 2022, pp. 9, 2022.

[17] L Ashok Kumar, Ramya Kuppusamy, Yuvaraja Teekaraman, V Indragandhi and Arun Radhakrishnan, "Design and Implementation of Automatic Water Spraying System for Solar Photovoltaic Module", Mathematical Problems In Engineering., vol. 2022, pp. 9, 2022.

[18] Yuvaraja Teekaraman, KA Ramesh Kumar, Ramya Kuppusamy and Amruth Ramesh Thelkar, "SSNN Based Energy Management Strategy in Grid-Connected System for Load Scheduling and Load Sharing", Mathematical Problems In Engineering., vol. 2022, pp. 9, 2022.

[19] M. Bharathidasan, V. Indragandhi, Ramya Kuppusamy, Yuvaraja Teekaraman, Shabana Urooj and Norah Alwadi, "Intelligent Fuzzy Based High Gain Non-Isolated Converter for DC Micro-Grids", CMC-Computers Materials Continua., vol. 71, no. 2, 2022.

[20] Kamaleshwar T, Lakshminarayanan R, Yuvaraja Teekaraman, Ramya Kuppusamy and Arun Radhakrishnan, "A Self-Adaptive framework for Rectification and Detection of Blackhole and Wormhole attacks in 6LoWPAN", Wireless Communications And Mobile Computing., vol. 2021, pp. 1-8, 2021.