Brain Tumor Detection with Hospital Recommendation System

Sharmila Rathod[1], Somesh Kshirsagar[2], Kartikkumar Mahindrakar[3], Vinayak Maskar[4], Prajwal Nanaware[5]

[1]*Professor, Computer Engineering, MCT's Rajiv Gandhi Institute of Technology, Mumbai University*

[2,3,4,5]*Student, Computer Engineering, MCT's Rajiv Gandhi Institute of Technology, Mumbai University*

***Abstract*—The main controller of the humanoid system is the human brain. A brain tumor can form as a consequence of the abnormal growth and division of brain cells, such conditions will get worse. The traditional method of detecting tumor by magnetic resonance imaging (MRI) is done by human inspection. This method has been known to have high rates of error due to errors made by humans, leading directly to patient casualties. To avoid human casualties during the inspection process, automatic and reliable classification schemes are necessary.**

In this paper, we proposed an android application that provides a novel method that uses Brain MRI images to detect the presence of tumor followed by recommendations of the hospital. Our app takes brain MRI images of patients as input and detects the presence of tumor. Furthermore, all useful data from various hospitals is taken into consideration then useful and appropriate information about brain tumor is recommended to the user as well as hospital which are specialized to treat the tumor is recommended based on various attributes such as location, medical specialties, quality of care, and patient satisfaction ratings. Along with the recommendation, the confidence of the detection is also displayed to the user so that the user gets the assurance of results generated by the system. As a result the user can receive essential medical advice and treatment as soon as possible.

Keywords:* *Brain Tumor, Accuracy, Detection, MRI, Recommendation.

I. INTRODUCTION

Brain tumor is the major cause of death globally. Early diagnosis is important for effective treatment. Advancements in medical imaging technology have enabled the early detection of brain tumor through MRI scans. However, the accurate interpretation of these images requires significant expertise and time from specialized healthcare professionals. Therefore, there is a need for a reliable and efficient system for brain tumor detection that can aid healthcare professionals in the timely diagnosis and treatment of brain tumor.

A brain tumor can be benign or malignant and can affect people of all ages. Early detection of brain tumor is crucial for effective treatment as it increases survival rates. In recent years, there has been an increase in the development of mobile applications aimed at improving healthcare.

In this paper, we propose a system for brain tumor detection with a hospital recommendation that can assist patients in detecting brain tumor at an early stage and help them find the best hospitals for treatment. The brain tumor detection app is designed to use machine learning algorithm to analyse medical images of the brain and detect any abnormal growths of tumor. The app will be user-friendly, and patients can easily upload their MRI images for analysis. Once the analysis is complete, the app will provide the user with a report on whether the tumor is present in the brain. The hospital recommendation system will recommend the best hospitals by considering attributes such as location, medical specialties, quality of care, and patient satisfaction ratings. Patients can use this information to make informed decisions on where to receive treatment.

2.LITERATURE REVIEW

Keerthan et al. [4] developed an efficient technique that describes the pre-processing used to enhance the image without changing the information content. This article discusses the main causes of image artifacts such as image artifacts, poor resolution, low contrast, and geometric distortion. The extraction function was then used to extract image features from the data sets. This system gave an average score for accurate tumor detection, but the classification of tumors is not complete. K-means were applied to the options extracted from the image using spot blending and later the technique of machine learning with support vectors (SVM) to be applied effectively. This technique identified abnormalities in the brain discovered in an image of an adult male. The system required fewer training kits and helped identify the tumor faster and ensure correct results. Dhanashri Gujar, Rashmi Biyani Tejaswini, Bramhane Snehal, Bhosale Tejaswita, P.Vaidya "Disease Prediction and Physician Recommendation System" in the International Research Journal of Engineering and Technology (IRJET).

Tonmoy Hossain et al. [2] proposed a method to extract brain tumors from 2D magnetic resonance imaging (MRI) brain images by using fuzzy C-means clustering algorithm followed by traditional classifiers and clustering networks of convolutional neurons. Subsequently, an experimental study was performed on a real-time data set with different sizes, locations, shapes of the tumors and different image intensities. The main goal of their research was to distinguish between normal and abnormal pixels based on statistical and texture-based features.

P Gokila Brindha et al. [3] use deep learning techniques to show whether the brain is normal or diseased. The article focuses on creating a self-defined model architecture for ANNs and CNNs and finally compares the performance of ANNs and CNNs when applied to a brain tumor MRI dataset. The data set was pulled from a GitHub page that contains MRI images of brain tumors. There were two folders, one with a normal brain image and the other with a tumor image.Both ANN and CNN techniques were applied to the brain tumor dataset and their performance in image classification was analyzed. The model developed in their project was generated through trial and error.

Dhanashri Gujar et al. [5] proposed a new method using a data mining technique, namely the Naive Bayes classification algorithm, to predict the disease, followed by a medical specialist's recommendation of the predicted disease. They tried to implement healthcare machine learning capabilities within one system. This project mainly focused on the development of an emergency medical care system that captures patient's symptoms and other medical data and stores them in an intelligent health record, which is then analyzed using the Bayesian Automatic naïve learning algorithm, resulting in the highest accuracy.

Vinod Kumar Shukla et al. [6] aim to develop a medical chatbot with AI that can diagnose a disease and provide basic information about the disease before consulting a doctor. The design was created to save the user time when consulting doctors or experts for a healthcare solution. They developed an application using N-Gram, TF-IDF, to extract a keyword from a user's query. Each keyword was weighted to get the correct answer to question. The app has been improved with security and performance updates that ensure user and character protection and consistent retrieval of answers to questions.

3.PROPOSED METHODOLOGY

An intelligent system that can accurately detect brain tumor and recommend suitable hospitals is vital for effective treatment. The proposed system is comprised of two distinct steps. Firstly, a Convolutional Neural Network (CNN) architecture is utilized to detect brain tumor from MRI images. Secondly, a hospital recommendation system is implemented using Content-Based Filtering using cosine similarity. The system flow of the proposed approach is shown in Fig 2.

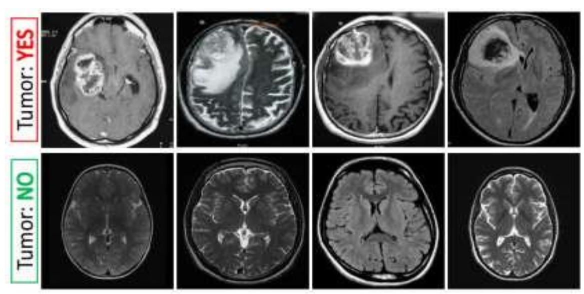

Fig. 1. Brain MRI images dataset sample

3.1 Brain Tumor Detection Using CNN

Convolutional Neural Network (CNN) architecture is utilized to detect brain tumor from MRI images. Tumor detection is comprised of four distinct steps. Firstly, data is collected and preprocessed. Secondly, verification of MRI images is done. Third, a convolutional neural network is Trained on the preprocessed data. Lastly, Evaluating the model's performance on a separate dataset using metrics like accuracy, precision, and recall.

3.1.1 Preprocessing

Due to subject motions during acquisition or MRI machine restrictions, MRI images may accumulate anomalies such as inhomogeneity distortions and heterogeneity of motion. These artifacts cause spurious intensity rates to be introduced, which results in false positives in the image. Initially, preprocessing was applied once the MRI picture was supplied. Because the black corners of the intensity values in MRI images vary, it is difficult for CNN to get used to the specifics of each class designation.

3.1.2 Dataset Splitting

Data splitting involves dividing the available dataset into training, validation, and testing sets. The primary goal of data splitting is to evaluate the performance of the model on unseen data and to prevent overfitting. Here the data is divided into an 80:20 ratio, where 80% is designated as the training data, and the remaining 20% is further subdivided into two equal parts. Specifically, 10% of the data is allocated to the testing set, and the other 10% is allocated to the validation set.

3.1.3 Verification of MRI Images

Verification of MRI images is essential to ensure that only valid images are used as input for brain tumor detection. To achieve this, a Convolutional Neural Network (CNN) is employed to classify input images as MRI or non-MRI images. To begin, the input image is converted to black and white (grayscale) format, as this reduces the complexity of the image and makes it easier for CNN to extract features. Next, the preprocessed image is fed into a CNN model that is designed to classify images as MRI or non-MRI. The model is trained on a dataset of labeled MRI and non-MRI images. Then the trained model is used to predict whether a given input image is an MRI image or not.

3.1.4 Convolutional Neural Networks (CNN)

An effective way to extract key features from images, analyze those features, and categorize them is to use convolutional neural networks (CNNs). The basic CNN architecture consists of three main layers: the convolution layer, the pooling layer, and the fully connected layer. Convolutional layers only function on a certain location, not everywhere. By doing so, the distinctions from the original data are separated, and the layer before it is transformed into the layer. Following that, the pooling layer starts to take the knowledge from the previous layer into account and works to make the task easier. The fully linked layer executes the features that have been gathered from all preceding layers to produce the necessary categorized outputs.

The proposed CNN system has many steps. First, the app takes MRI image of the brain as an input. Next, data normalization is performed, applying image thresholds and noise-free extensions. The gathered database of brain MRI images is processed and expanded. The image is then scaled from the initial input and the pre-trained CNN is used to classify the images into two classes YES and NO.

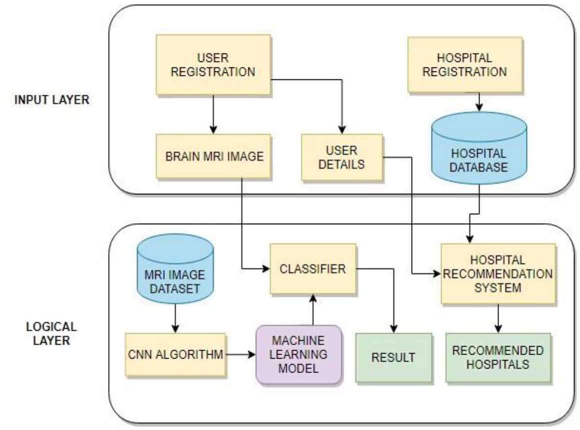

Fig. 2. System Architecture

3.2 Hospital Recommendation system

A hospital recommendation system is based on content-based filtering using cosine similarity is a system that recommends hospitals to users based on their selected hospital. The system uses a content-based approach, which means that it analyzes the attributes of the hospitals and the user's selected hospital to recommend hospitals that are most similar to the user's preferences.

3.2.1 Content-Based Recommendation

Content-based recommendation for hospital recommendation refers to a technique that utilizes the attributes of a hospital to recommend similar hospitals to a user. The recommendation process begins by showing the user a list of hospitals with their attributes. The user then selects a hospital from the list that they want to use as a reference hospital.

Once the user has selected a hospital, the system creates a profile for that reference hospital using its attributes and compares it to the attributes of other hospitals in the list. Then the system would recommend hospitals that have the most similar attributes with the reference hospital. To generate these recommendations, the system uses a similarity metric i.e.,cosine similarity.

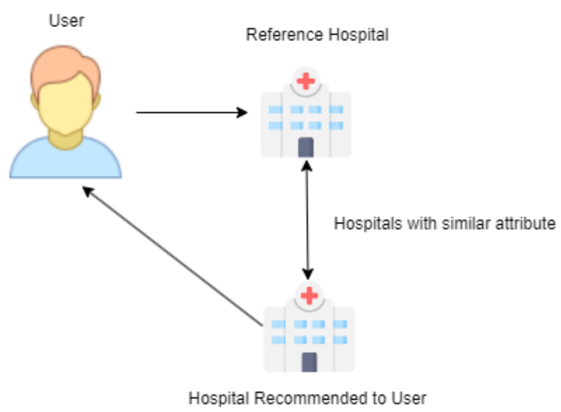

Fig. 3. Content-Based Filtering

3.2.2 Cosine Similarity

Cosine Similarity is a metric used to measure how similar two items are. Mathematically, it measures the cosine of the angle between two vectors projected in a multi-dimensional space. The output value ranges from 0 to 1. In which 0 means no similarity, whereas 1 means that both the items are 100% similar.

When the user selects a hospital from the list that they want to use as a reference hospital. Then the system generates a hospital profile based on the attributes of that reference hospital. The profile serves as a representation of the hospital in terms of its attributes, such as its medical specialties and quality of care. The system then calculates the cosine similarity between the hospital profile of the reference hospital and the hospital profiles of all other hospitals in the list. In this case, the hospital profiles are represented as vectors in a high-dimensional space, and cosine similarity measures how close the vectors are to each other. The system then ranks the hospitals based on their cosine similarity to the selected hospital and presents the top-ranked hospitals as recommendations to the user. The higher the cosine similarity between the hospital profiles, the more similar the hospitals are in terms of their attributes.

$$cos(\theta) = \frac{A \cdot B}{||A|| \, ||B||} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \sqrt{\sum_{i=1}^{n} B_i^2}}, i = 1, 2 \ldots n \quad (1)$$

A = Reference Hospital Vector

B = Hospital Vector

4.EXPERIMENTAL SETUP

4.1 Details of Dataset

4.1.1 Brain Tumor Detection dataset

The dataset we have collected is from Kaggle, which was the foundational need of the project. It consists of 3000 images belonging to two classes ‘Yes’ and ‘No’. Class labelled with 'Yes' has 1500 Brain MRI images showing presence of tumor while class labelled with 'No' has 1500 Brain MRI images showing absence of tumor.

4.1.2 MRI Image Verification dataset

The dataset used for MRI image verification consists of 365 images, which are divided into two distinct classes - 'MRI image' and 'non-MRI image'. The class labeled as 'MRI image' contains 155 real MRI images of the brain, whereas the class labeled as 'non-MRI image' contains 210 images which do not belong to the MRI category.

4.2 Performance Evaluation Parameters (for Validation)

Parameters such as confusion matrix, recall, precision, accuracy, and loss are used in our model.

Training and Validation Accuracy: In the below Fig. 6 the curve in blue indicates the model classifying images while training the data-set whereas the curve in orange indicates the accuracy we calculate for data-set and used for validating the model.

Training and Validation Loss: In the below Fig. 7 the curve in blue indicates how well the model is fitting the training data, while the orange curve indicates how well the model fits new data.

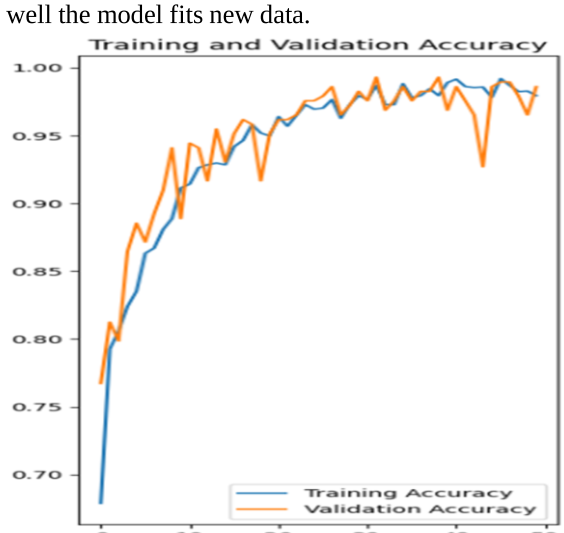

Fig. 4. Training and Validation Accuracy

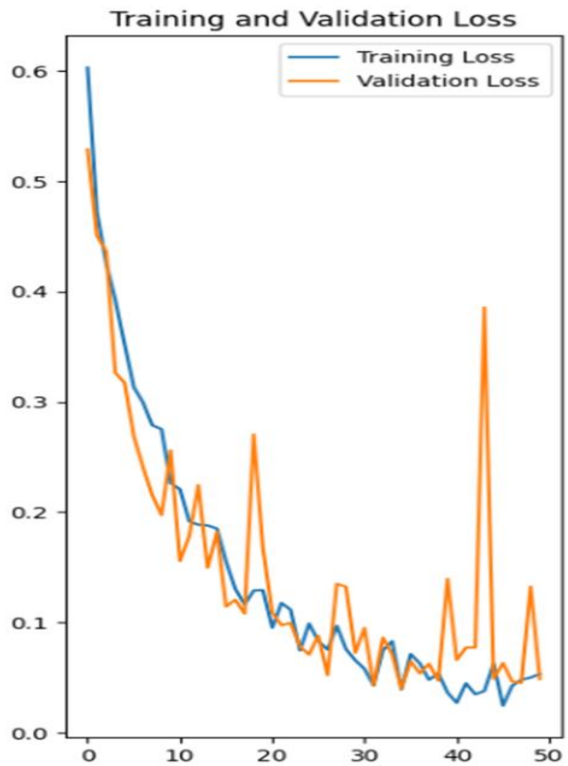

Fig. 5. Training and Validation Loss

Accuracy: Accuracy of our model achieved stands at 98.61%.

Confusion Matrix: To describe how well a categorization method performs, a confusion matrix is utilised. A confusion matrix summarises and depicts how well a classification method performed. We may assess recall, accuracy, and precision using this helpful machine learning technique.

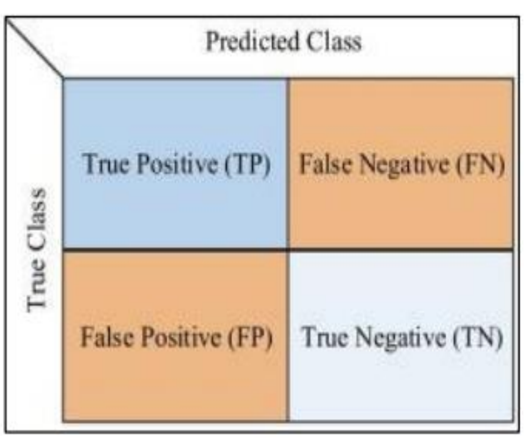

Fig. 6. Confusion matrix representation

Following diagram describes the Confusion Matrix of Our CNN Model.

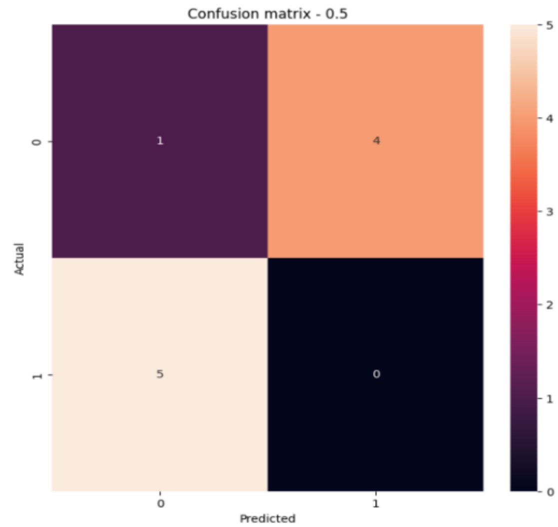

Fig. 7. Confusion matrix of our project model

Recall: How many accurately anticipated classes out of all the positive classes can be used to explain the equation below. The highest recall level is desirable.

$$\textit{Recall} = \frac{TP}{TP + FN}$$

$$\textit{Recall} = 0.20$$

Precision: How many of the classes we projected as positive actually are positive can be used to explain the equation below. As much precision as possible should be used.

$$\textit{Precision} = \frac{TP}{TP + FP}$$

$$\textit{Precision} = 0.167$$

5. CONCLUSION

The development of brain tumor detection with a hospital recommendation system will be an innovative and reliable approach for the detection of brain tumor. The proposed system also offers, recommending suitable hospitals for treatment, saving time for patients in the search for the best treatment options.

The testing of the app's performance on a large dataset of brain MRI images demonstrates the excellent accuracy of the algorithm in the detection of brain tumor. The integration of the hospital recommendation system improves the app's overall performance by providing users with information on the best hospitals based on multiple parameters. This system can potentially improve patient outcomes and reduce the work of healthcare professionals.

In conclusion, brain tumor detection with a hospital recommendation system will be a promising contribution to the field of medical science. The proposed system will help in the early detection of brain tumor, potentially leading to better patient outcomes. The system's user-friendly interface makes it an efficient and innovative solution for the detection of brain tumor. Further research and development are necessary to improve the system's performance and expand its capabilities for other medical conditions.

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