# BRAIN TUMOR DETECTION USING SUPPORT VECTOR MACHINE (SVM)

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**ABSTRACT:**

Tumors are the leading cause of cancer. The medical field requires a fast, automated, effective method for detecting tumors such as brain tumors. Detection of brain tumors in medical images is always a challenging task. Characteristics like size, shape, and position of tumor vary from different patient’s brain. So, it's important to know the exact texture of a tumor in the brain, making it a challenging task for detection. Doctors manually locate the position and area of a brain tumor by inspecting the patient's MRI images of the brain. This leads to inaccurate tumor detection and is considered time-consuming. If proper tumor detection is possible, Doctors can use this application to provide proper treatment and save several tumor patients This study employs a variety of image processing techniques. In this paper, we will discuss which algorithm is most effective at predicting whether a brain tumor is present in an MRI image. “***The detection technique based on support vector machine (SVM) and logistic regression***” is proposed and applied to the process of detecting brain tumor images. This intelligent system will improve accuracy and reduce brain tumor error rates.

KEYWORDS: Accuracy rate, Brain Tumor; MRI Image; Logistic Regression, Support Vector Machine (SVM)

# 1.INTRODUCTION:

Currently, doctors inspect the patient's MRI images of the brain to manually locate the position and area of a brain tumor. This results in inaccurate tumor detection and is time-consuming. A tumor is an uncontrollable growth of tissue.

We will discuss which algorithm is most effective at predicting whether a brain tumor is present in an MRI image in this paper. "The support vector machine (SVM) and logistic regression "detection techniques are proposed and applied to the process of detecting brain tumor images. This intelligent system will increase accuracy while decreasing brain tumor error rates.

**1.1 INDICATION OF BRAIN TUMOUR**

A brain tumor is essentially an abnormal development of cells in the brain. Brain tumors are classified into two categories: benign, which are non-cancerous, and malignant, which are cancerous. The transition to a high-grade tumor occurs more frequently in adults than in children. The white spots in the middle of the grey matter are visible in the MRI scan images of the tumor. The following are the actual symptoms of a brain tumor:

The chances of developing a cancerous brain tumor in your lifetime are less than 1%. Symptoms such as a headache or confusion are usually your body's way of telling you to drink more water or sleep more.

However, these symptoms rarely indicate a larger problem. Unfortunately, the symptoms of a brain tumor can be as varied as the brain's never-ending list of responsibilities. "There is no specific symptom of a brain tumor," neurosurgeon Gene Barnett, MD, says. "Depending on where the tumor is located, a brain tumor can present with a variety of signs and symptoms.

**1.2 SIGNS TO WATCH OUT FOR**

With over 120 different forms of brain tumors, symptoms range from none to big red flags. Finally, how your body sounds the alarm is determined by:

* + Where the tumor develops.
  + What aspect of your body is controlled by the damaged section of your brain.
  + The size of the tumor.

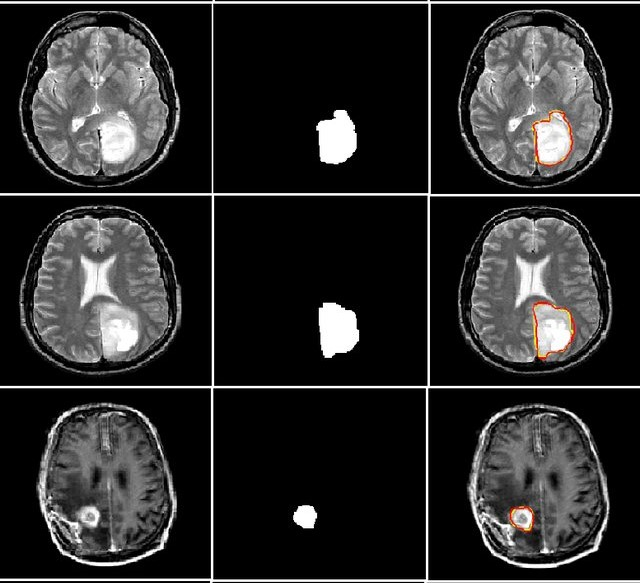


Fig 1: MRI Scanned image and tumor detect part in human brain.

To determine when a symptom is serious, you must first understand your own body. Health changes might be just as informative as the disease itself.

Dr. Barnett advises visiting a medical practitioner if you have one or more of the following symptoms:

➢ Seizures: A tumor can cause your brain's neurons to function erratically, resulting in seizures.

➢ Changes in your mental status: Perhaps you've had too many "senior moments" or you've had more difficulties than normal figuring out a restaurant bill. Your mental talents are unique to you, and any modifications to them are as well.

➢ Personality or behavioral changes: "Frontal lobe tumors in particular can cause joyful, effervescent people to adopt a flat affect or some generally quiet people to become more vocal," Dr. Barnett adds. "They can also induce inhibition loss."

➢ Clumsiness: Brain stem tumors can cause dizziness or clumsy movements.

➢ Headaches: "Brain tumor headaches typically last more than a few days, are accompanied by nausea or vomiting, and occur early in the morning". "At the same time, most headaches are not caused by a brain tumor," Dr. Barnett adds.

**1.3 MOTIVATION**

➢ Early detection of brain tumors.

➢ Reducing the strain on human judgement.

➢ Design a user interface for detecting malignant cells.

➢ Early detection helps to reduce the mortality rate.

➢ Supporting speedier communication in situations when the patient can be extended to a remote location.

➢ Tamil Nadu's opinion on the well-adaptation of automated medical image analysis.

**2.REVIEW OF LITERATURE:**

[1] *Vinay J. Nagalkar, Dr. G.G. Sarate [2019]* has suggested an Experimental result shows the accuracy rate of correctly identifying the brain tumor in the input CT scan image using Linear function Support Vector Machine 32 images out of the 50 images are correctly classified giving an overall accuracy of classifier as 64%. The time required for the detection shows the detection and identification time of classifier to find the disease.[1] Time taken by LF SVM to detect the tumor is 0.3525 seconds. The proposed system with Linear Function Support Vector Machine classifier gives better and perfect results to doctors for detecting and discerning brain disease.

[2] In this paper, the authors *S.S. Dharun Raj, S. Hariharan [2021]* have analyzed the content for Brain “Tumor Detection and Classification Using SVM [Support Vector Machine]”. According to statistics, the population of cancerous people in India is about 12.7 million every year, with 7.6 million people dying because of cancer. Usually most normal cells die as they age or become damaged, and new cells replace them. This procedure may sometimes go wrong [2]. When the body doesn't need new cells, they want to form, and old or damaged cells don't die as they should. A growth or tumor is a mass of tissue formed by the accumulation of extra cells. There are two types of primary brain tumors: benign and malignant. Benign brain tumors do not contain cancer cells. Benign tumors can usually be removed, and they seldom grow back. Benign brain tumors typically have a distinct edge or border. Benign tumor cells rarely enter the tissues around them. They are not infectious and do not spread to other areas of the body. Cancer cells are present in malignant brain tumors (also known as brain cancer). Malignant brain tumors are more dangerous and pose a life-threatening threat. The support vector machine algorithm's goal is to find a hyper plane in an N-dimensional space (N — the number of features) that distinguishes between data points. There are several hyper planes from which to pick to distinguish the two types of data points. Our aim is to find a plane with the greatest margin, or the greatest distance between data points from both groups. Maximizing the margin gap provides some reinforcement, making it possible to distinguish potential data points.

[3] *Priyanka Arya and Anil Kumar Malviya [2020]* proposed even with tremendous advancement in medical technology tumor segmentation remain most tedious and complex work for doctors. Magnetic Resonance Imaging (MRI) is the most used technique by the radiologist for inspection of internal human body parts without any dissection, but manual inspection consumes time and precious work hours [3]. A possible solution for early detection of diseases such as tumors and cancer can be computer-aided image analysis. Precise futuristic classification of brain tumor form the MRI image is very important as it will lead to early detection, reduction in work hours and mistakes, propagation of automation in tumor removal and will also help to decide the course of treatment. Considering the difficulties, this work is aimed at highlighting the techniques proposed in contemporary literature by summarizing the novel facts of research.

[4] The idea behind the research paper by *Jyostna Devi Bodapati, Annepu Vijay, Naralasetti Veeranjaneyulu [2020]*is to diagnose brain tumors by identifying the affected regions from the brain MRI images using machine learning approaches. In the proposed approach, prominent features of the tumor images are collected by passing them through a pre-trained Convolutional Network, VGG16. Observed that SVM gives better accuracy than other models. Though achieved 84% accuracy [4]. To make the model more robust, we obtained the most discriminant features, by applying Linear Discriminant Analysis (LDA) on the features obtained from VGG16. Used different conventional models like logistic regression, K-Nearest neighbor classifier (KNN), Perceptron learning, Multi Layered Perceptron (MLP) and Support Vector Machine (SVM) for the comparison study of the tumor image classification task.

[5] In this paper the authors *v.v.s. vishal, mohan sai kothapalli, ch. murali krishna sai, akshitha punna, venubabu rachapudi [2022]* have been discussed about the Image segmentation is the process of putting together parts of an image that belong to the same category. This process is also called pixel level separation. In other words, it involves dividing images (or video frames) into several parts or objects. Pre-data processing is the process of preparing raw data and adapting it to a machine learning model. It is the first and most important step in creating a machine learning model. Real-world data usually contains sounds, missing values, and perhaps in an unusable format that can be used directly by machine learning models. The image is first segmented and resized then the data is processed and fitted into the model [5]. In feature selection and extraction, the exact data required is extracted from dataset. The accuracy is checked using different algorithms and the algorithm that gives more accuracy compared to others is determined.

**3.METHODOLOGY OF THE STUDY:**

The methodology for brain tumor detection using Support Vector Machines (SVM) and Logistic Regression typically involves several key steps. Here's a brief overview:

* 1. Data Collection: Gather a dataset of medical images (e.g., MRI or CT scans) that includes both brain tumor (positive) and non-tumor (negative) cases. This dataset serves as the foundation for the detection model.
* 2. Data Preprocessing: Preprocess the medical images to enhance their quality. This may include tasks like noise reduction, image normalization, and resizing.
* 3. Feature Extraction: Extract similar features from the preprocessed images. These features could include texture, shape, or intensity characteristics that are useful for distinguishing between tumor and non-tumor regions.
* 4. Data Splitting: Split the dataset into training, validation, and testing sets. The training set is used to train the SVM and Logistic Regression models, the validation set helps fine-tune model parameters, and the testing set is used for final evaluation.
* 5. Model Development: Develop two separate classification models using SVM and Logistic Regression. Train these models using the training dataset and the extracted features.
* 6. Hyperparameter Tuning: Fine-tune the hyperparameters of both models using the validation dataset. Common hyperparameters include the regularization strength (C) for SVM and the regularization parameter (lambda) for Logistic Regression.
* 7. Model Evaluation: Evaluate the performance of both models using the testing dataset. Common evaluation metrics include accuracy, sensitivity, specificity, ROC curves, and AUC (Area Under the Curve).
* 8. Model Comparison: Compare the performance of the SVM and Logistic Regression models to determine which one is more effective in brain tumor detection based on the chosen evaluation metrics.
* 9. Clinical Application: If the model's performance is satisfactory, consider the practical application of the chosen model in clinical settings for early diagnosis and patient care.
* 10. Cross-Validation (Optional): - Perform k-fold cross-validation to assess the model's generalizability and robustness on different data subsets.
* 11. Ethical Considerations: - Address ethical issues related to data privacy, informed consent, and the responsible use of patient data in medical research.
* 12. Reporting and Documentation: - Prepare a report or publication detailing the methodology, results, and conclusions of the study, and discuss the potential impact of the models on clinical practice.
* 13. Future Directions: - Suggest future research directions or improvements, such as exploring deep learning approaches or incorporating additional data sources.

**4.OBJECT OF THE STUDY:**

The main objective of brain tumor detection is to accurately and early identify the presence and characteristics of brain tumors in medical images, such as MRI or CT scans and this improving patient outcomes and prognosis. This objective serves several critical purposes:

1. Early Diagnosis
2. Patient Care
3. Reduction of Misdiagnosis
4. Precise Treatment Planning
5. Improved Prognosis
6. Research and Innovation

**5.CHALLENGES FOR AFFILIATE BRAIN TUMOR DETECTION USING SVM:**

Affiliate brain tumor detection using SVM faces hurdles like safeguarding sensitive patient data, dealing with varied data sources, and ensuring privacy and security. It also requires integrating models from different parties, consistent labeling, and navigating legal and ethical concerns. Establishing collaboration agreements and regulatory compliance is vital. Overcoming these challenges demands innovative technical and collaborative solutions while maintaining the highest standards of patient care and data security.

**6.ALGORITHM**:

SVM (SUPPORT VECTOR MACHINE) CLASSIFICATION:

Support Vector Machine, or SVM, is a well-known approach for Supervised Learning that is applied to both classification and regression applications. However, it is predominantly employed in Machine Learning for Classification issues.

The objective of the SVM method is to discover the optimal line or decision boundary for categorizing n-dimensional space so that subsequent data points may be readily assigned to the relevant category. A hyperplane is the optimal choice limit. SVM chooses the extreme points and vectors that contribute to the formation of the hyperplane. These extreme situations are known as support vectors, and the corresponding technique is called the support vector machine. Consider the following diagram, which depicts two distinct groups divided by a decision boundary or hyperplane.

**HYPERPLANE AND SUPPORT VECTORS IN SVM ALGORITHM:**

Hyperplane: Several lines/decision boundaries can be used to divide classes in n-dimensional space, however the effective decision boundary for classifying data points must be identified. The optimal boundary is referred to as the SVM hyperplane. The dimensions of the hyperplane depend on the number of features in the dataset, therefore if there are only two features (as seen in the figure), the hyperplane will be a straight line. And if the hyperplane has three characteristics, it is a two-dimensional plane. We always make a hyperplane with a maximum margin, which means the greatest possible distance between the data points.

SVM Model: SVM is a powerful classifier construction method. It aims to establish a decision boundary between two classes that allows label prediction from one or more feature vectors. This decision boundary, known as the hyperplane, is positioned so as to be as distant as feasible from the nearest data points from each class. These closest points are referred to as support vectors.

Given a tagged training dataset:

(x1, y1), ..., (xn, yn), xi ∈ R d and yi ∈ (−1, +1)

where xi is a representation of a feature vector and yi is the class label (positive or negative) of a training compound i.

The optimal hyperplane is then defined as:

wxT + b=0

Where w is the weight vector, x represents the input feature vector, and b represents the bias.

For all elements of the training set, w and b would satisfy the following inequalities:

wxi T + b ≥ +1 if yi=1 wxi T + b ≤ −1 if yi=–1

The objective of SVM model training is to select w and b so that the hyperplane separates the data while maximizing the margin.

1 / || w || 2 .

Vectors xi for which |Yi| (wxi T + b)= 1 will be termed support vector.

**7.DATASET DESCRIPTION:**

The MRI brain tumor dataset was generated through long-term cooperation with worldwide medical organizations and data optimization by subject matter specialists. In accordance with regulatory standards, all Medical Data Cloud data has been de-identified. This dataset contains 1220 images of human brain MRI images divided into two categories: no tumor and pituitary.

DATASETLINK: <https://www.medicaldata.cloud/data-sets/brain-tumor-mri-dataset>

**8.CONCLUSION AND FUTURE ENHANCEMENT:**

Experimental result shows the accuracy rate of correctly identifying the brain tumour in the input MRI [Magnetic Resonance Imaging] scan image using Support Vector Machine. SVM classification gives an overall accuracy of classifier as 87.5%. The time required for the detection shows the detection and identification time of classifier to find the disease. Time taken by SVM [Support Vector Machine] to detect the tumour is 0.3525 seconds. logistic regression classification gives an overall accuracy of classifier as 83.2%. So, The proposed system with Support Vector Machine classifier gives better and perfect result to doctors for detecting and discerning the brain disease.

As a future work, we can compare with any other contemporary algorithm and we are aiming to increase the size of the dataset by including more patients of different ages, symptoms, and gender.

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