INTELLIGENT BRAIN TUMOR DETECTION AND ANALYSIS WITH AI POWERED IMAGING

GL BAJAJ
Institute of Management & Research, PGDM Institute
Greater Noida
FIND YOUR SPARK

MEMBERS

1. Abhishek Kumar Chaurasia (2301921529001)
2. Bhanu Pratap Singh (2301921529003)
3. Harsh Kr Sharma (2301921529004)
4. Yuvraj Pandey (2301921529013)

Mentor:
Mr Satyam Saini

PROBLEM STATEMENT

The primary objective is to detect brain tumors and differentiate between tumor and non-tumor regions in MRI scans. Additionally, the system should be able to classify the type of tumor (e.g., benign vs. malignant) when possible, based on extracted features from the images.

MOTIVATION

Internal: Commitment to Social Responsibility of Saving Lives

External:
1. AI Specialisation.
2. Global Applications.
    - Watson AI of IBM which gives 99% accurate cancer prescription.
    - AlphaFold: predicted protein structures with remarkable accuracy using AI.

ABSTRACT

To develop an automated system for accurate brain tumor detection from MRI scans using Support Vector Machine (SVM) as the core algorithm. The system will classify tumor and non-tumor tissues, and potentially identify tumor types, by extracting key image features and training the SVM for high accuracy, precision, and recall. It aims to assist radiologists in early-stage tumor diagnosis with efficiency and robustness.

INTRODUCTION

Brain tumor detection is a critical task in medical imaging, as early diagnosis can significantly improve treatment outcomes. However, manual detection and diagnosis from MRI scans can be time-consuming, subjective, and prone to human error. Therefore, this project aims to leverage machine learning techniques, specifically Support Vector Machine (SVM), to build an automated system that can detect and classify brain tumors from MRI images with high accuracy.

TECHNOLOGY USED: SVM WITH PYTHON

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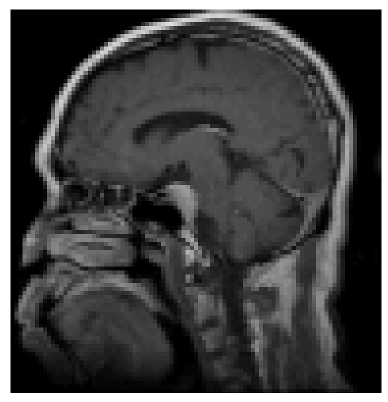
PROPOSED SOLUTION

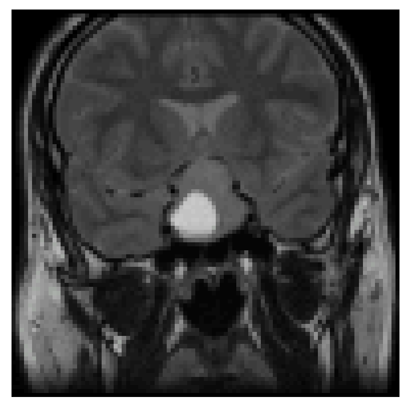
To develop an automated system for accurate brain tumor detection from MRI scans using Support Vector Machine (SVM) as the core algorithm. The system will classify tumor and non-tumor tissues, and potentially identify tumor types, by extracting key image features and training the SVM for high accuracy, precision, and recall. It aims to assist radiologists in early-stage tumor diagnosis with efficiency and robustness.

3 main stages → Image Preprocessing → Feature Extraction → SVM-based Classification

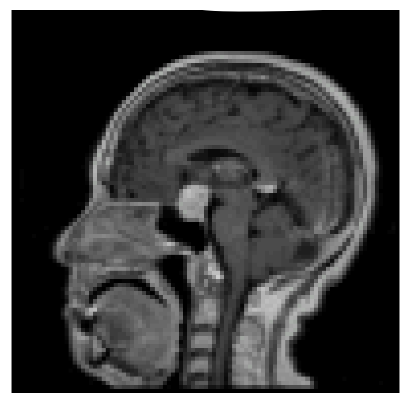
Glioma tumor



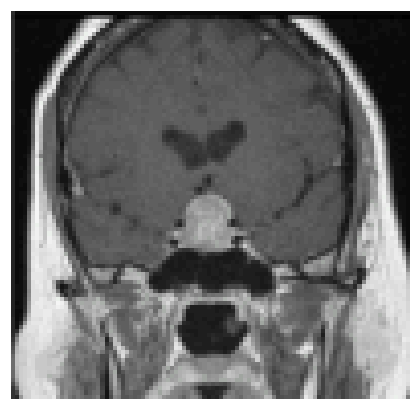
Meningioma tumor



Pituitary tumor



No tumor



WORKFLOW

a) Data Acquisition:

Collect labeled MRI images with both tumor and non-tumor regions from public repositories, hospitals, or research centers. The dataset will include positive (tumor) and negative (healthy) cases, split into training, validation, and testing sets.

b) Image Pre-processing:
- Noise removal: Applying filters to reduce image noise.
- Normalization: Standardizing pixel intensities.
- Skull stripping: Removing non-brain tissues.
- Segmentation: Isolating tumor regions.

c) Feature Extraction:
Extract relevant features, such as:
- Texture-based: Patterns using LBP, Haralick features, or GLCM.
- Shape-based: Geometry, size, and irregularities.
- Intensity-based: Pixel intensity distributions.

d) SVM-based Classification:
Train the SVM to distinguish between tumor and non-tumor images by:
- Training the SVM: Finding optimal hyperplane using appropriate kernel (linear, polynomial, or RBF).
- Tumor Type Classification (optional): Extend SVM for multi-class classification (benign vs. malignant) if labelled data is available.

e) Model Evaluation:
Evaluate system performance using:
- Accuracy: Proportion of correct cases.
- Precision: True positive tumor detections.
- Recall (Sensitivity): Correctly detected actual tumors.
- F1-Score: Balance of precision and recall.
- AUC: Classifier performance across thresholds.

BENEFITS FOR SOCIETY

1. Early Diagnosis improving patient outcomes
2. Objective Assessments
3. Reduces human error
4. Increased Accuracy with Machine Learning
5. Time Efficiency: Automating speeds up radiology
6. Advanced Insights: AI can analyze complex patterns, assisting in distinguishing tumor types and severity.
7. Cost-Effective: reduces the need for multiple tests, saving resources.

ACCELERATING INDIA TOWARDS SDG GOALS OF 2030

1. **SDG 3: Good Health and Well-being** - early detection and diagnosis will reduce mortality and improve well being.
2. **SDG 4: Quality Education** - the project can help train neurologists to analyse the data in simple manner and upgrade themselves to newer innovations.
3. **SDG 9: Industry, Innovation, and Infrastructure**- the project fosters innovation and resilient healthcare system.
4. **SDG 10: Reduced Inequalities** – AI-powered diagnostics can make healthcare for tumor more accessible and affordable.

ADVANTAGES OF USING SVM

- Effective with small datasets as in medical cases
- Better Handling of high-dimensional data like MRI images.
- Robust classification of classes: especially when data is not linearly separable

DISADVANTAGES OF USING SVM

- Data availability: annotated datasets required for reliable performance.
- Expertise of Doctors in technology usage needed.
- Model generalization across diverse data sets
- Real-time application: optimisation needed

CONCLUSION

The proposed SVM-based system for brain tumor detection assists radiologists by reliably and efficiently diagnosing tumors from MRI scans. Leveraging SVM's capabilities, the project aims to enhance accuracy, enable early treatment, and improve patient outcomes.