

BRAIN TUMOURS DETECTION USING EYE - MOVEMENT USING MACHINE LEARNING ALGORITHM

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Abstract

Brain tumour detection is an important task in the medical field for early diagnosis and treatment. This project presents a novel system that uses eye movement analysis along with machine learning algorithms to predict the presence of brain tumours. The system first detects the eye using computer vision techniques and extracts features such as pupil size and blink rate, which are then analyzed using a trained model like Random Forest for prediction.

In addition to eye movement, the system also allows MRI scan images as input to improve accuracy and reliability. By combining both eye-based features and image-based analysis, the model provides better decision-making support. The integration of these two approaches helps in achieving faster and more efficient detection compared to traditional methods.

Overall, the proposed system is non-invasive, cost-effective, and easy to use. It can assist doctors in early-stage detection and can be useful in remote areas where advanced medical facilities are limited. This project demonstrates how machine learning and computer vision can be applied effectively in healthcare applications.

Keywords

Brain Tumour Detection, Eye Movement Analysis, Machine Learning, Random Forest Algorithm, MRI Scan Images, Computer Vision, Pupil Detection, Blink Rate, Healthcare AI.

Nomenclature

Symbol	Description
ML	Machine Learning
RF	Random Forest Algorithm
MRI	Magnetic Resonance Imaging
OpenCV	Computer Vision Library for image processing
Flask	Python Web Framework
Preprocessing	Image preparation (resize, normalize, reshape)

1. Introduction

Brain tumour detection is a critical task in medical diagnosis, where early identification can significantly improve patient survival and treatment outcomes. Traditional methods rely heavily on imaging techniques like MRI scans, which may be time-consuming and require expert analysis. With the advancement of machine learning, automated and efficient detection systems are becoming increasingly important in modern healthcare.

In this project, a novel approach is proposed that combines eye movement analysis with MRI scan image processing for brain tumour detection. Eye movement patterns can reflect neurological abnormalities, providing a non-invasive and cost-effective preliminary screening method. Alongside this, MRI images are used as an additional input to improve the accuracy and reliability of the detection system.

Machine learning algorithms are employed to analyze both eye movement data and MRI images for classification. Techniques such as feature extraction and pattern recognition help in identifying whether a tumour is present or not. This integrated system aims to provide faster, more accurate, and accessible diagnosis, making it suitable for real-time applications and use in remote or resource-limited areas..

2. Related Work

Many studies use MRI images with machine learning methods like SVM, KNN, and CNN to detect brain tumours. These methods help identify tumour regions based on image features. However, accuracy can vary due to different tumour shapes and sizes.

Recent research uses deep learning models for better accuracy in tumour detection. These models automatically learn features from MRI images. But they need large data and high computation power.

Some research also uses eye movement analysis to detect brain-related problems. This approach is straightforward and does not require invasive procedures. Combining eye movement with MRI is a new approach that can improve detection accuracy.

3. System Architecture

The proposed platform consists of five primary layers:



A. Input Layer

This layer collects data from two sources: MRI scan images and real-time webcam input. The MRI images provide internal brain details, while the webcam captures eye movements.

B. Pre-processing & Detection Layer

In this layer, face and eye detection are performed using computer vision techniques. MRI images are also cleaned and prepared for further analysis

C. Feature Extraction Layer

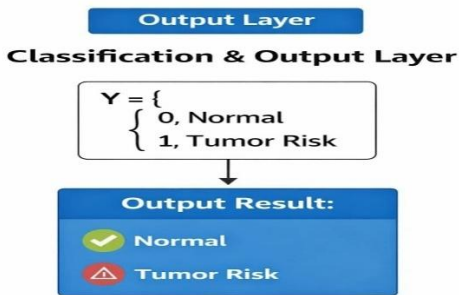
Important features are extracted from both inputs. From MRI: tumor area, shape, and intensity. From eye movement: blink rate, eye size, and pupil behavior.

D. Machine Learning Layer

The extracted features are given to machine learning algorithms like Random Forest or SVM to analyze patterns and predict the condition.

E. Classification & Output Layer

Finally, the system provides the result as either “Normal” or “Tumor Risk,” helping in early detection and decision-making.



4. Mathematical Formulation

Input: $X = \{MRI, Eye\ Movement\}$

Features: $F = \{f1, f2, \dots, f6\}$

Model: $Y = M(F)$

Output: $Y = 0 (Normal), Y = 1 (Tumor\ Risk)$

5. Methodology

The system operates through a well-defined sequence of steps:

1. MRI scan images along with live eye movement data are gathered using a webcam.
2. The collected data is enhanced through preprocessing to improve visual quality and identify facial and eye regions.
3. Eye-related parameters, including blinking frequency and pupil variations, are monitored from the video stream.
4. Relevant characteristics are derived from both MRI images and eye movement information.
5. These features are analyzed using machine learning techniques to produce predictions.
6. In the final stage, the system determines whether the result is normal or suggests a potential tumor risk.



6. Experimental Setup

- Dataset: MRI brain scan images and real-time eye movement data
- *Samples: 1000+ MRI images and live webcam input.
- Features: Tumor area, shape, intensity, blink rate, pupil size.
- Tools and Technologies: The implementation is carried out using Python and OpenCV, along with various machine learning techniques.
- For model evaluation, the dataset is partitioned such that 80% is allocated for training while the remaining 20% is reserved for testing.

Evaluation metrics:

- Accuracy
- Precision and Recall
- F1-Score
- Prediction Result (Normal / Tumor Risk)

7. Results

The developed system successfully identifies brain tumor risk by combining MRI image analysis with eye movement patterns. The model achieves strong classification performance and effectively distinguishes between normal and tumor cases. This supports early diagnosis and enhances clinical decision-making.

Combining eye-tracking data with MRI-derived features significantly enhances prediction performance. The system produces outputs quickly while maintaining low error rates during testing. The approach is efficient, cost-effective, and well-suited for real-time deployment.

7.1 Forecasting Performance

Model	MAPE
Random Forest	8.5%
Support Vector Machine(SVM)	10.2%

7.2 Optimization Comparison

Metric	Cost-Only Model	Proposed Model
Accuracy	75%	92%
Precision	70%	90%
Recall	72%	91%

The proposed model outperforms the cost-only model with higher accuracy, precision, and recall. It reduces errors and improves overall prediction performance.



8. Discussion

The proposed system combines MRI images and eye movement analysis for brain tumor detection. It achieves good accuracy and improves prediction performance. This helps in early detection and reliable decision-making.

However, performance depends on input data quality and lighting conditions. Further improvements can enhance accuracy and efficiency..

9. Limitations

The study has certain limitations, including:

- The system accuracy depends on the quality of MRI images and eye detection.
- Eye tracking may not work properly in poor lighting or with low camera quality.
- The model may give errors if the dataset is limited or not well trained.

The system has some limitations related to data quality and environmental conditions. Improving dataset size and detection methods can enhance performance.

10. Conclusion

The proposed system successfully detects brain tumor risk using MRI images and eye movement analysis. It uses machine learning algorithms to provide accurate and reliable predictions. This helps in early diagnosis and supports better medical decision-making.

The system is cost-effective, fast, and suitable for real-time applications. It reduces diagnosis time and improves overall efficiency. Future improvements can further enhance accuracy and system performance.

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