Brain Tumour Detection in Foetus and Infant using Deep Learning technique

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Abstract: Brain tumours are a major medical concern, particularly in foetus and infants, where prompt and accurate diagnosis is essential for effective treatment and improved outcomes. Magnetic resonance imaging (MRI) and ultrasound are two important imaging modalities that provide detailed insight into brain structure and abnormalities. It's also important to ensure independence will enter in due course. Brain tumours can range from benign, such as pituitary tumours, to aggressive, such as gliomas and meningiomas. Early and accurate diagnosis enhances outcomes and reduces the risk of long-term complications.

This work exploits the power of convolutional neural networks (CNNs) to classify brain tumours from MRI and ultrasound images. Convolutional neural networks excel in image classification by directly learning spatial features from raw image data, eliminating the need for manual filtering. The CNN model is designed to classify brain tumours, including Meningioma tumour, Pituitary tumour, Glioma tumour, and no tumour.

The performance of the model is evaluated using key parameters such as accuracy, sensitivity, specificity, and F1 score. This design highlights the deep learning capabilities of medical imaging, providing an effective non-invasive method for the early detection of brain tumours in foetus and infants. Transferable results are reliable and fast. The proposed system aims to help health professionals make rational decisions, ultimately improving the quality of prenatal care for infants.

Keywords: Medical Image Processing, Foetus brain tumour, Meningioma Tumour, Pituitary tumour, Glioma tumour.

I.INTRODUCTION

Brain tumours in foetus and infants, although rare, are very serious and can severely affect a child's early development and long-term health Early diagnosis is important, as it can influence treatment decisions to increase his chances of survival. Typically, MRI and ultrasound scans are used to diagnose these tumours', but interpretation of these images is a complex task that requires a high level of expertise, making the process time-consuming and prone to human error This is where Convolutional Neural Networks (CNNs), powerful deep learning, comes into play. They offer a promising solution to classify and detect brain tumours in fetal and infant MRI and ultrasound images. In our study, we used a CNN model to classify brain tumours in fetal infant brain scans using the resulting MRI and ultrasound images Surprisingly, and emphasizes the power of CNN in the early detection and classification of brain tumours' a time when Intervention is needed The thing is, However, the journey is not without its challenges. There is variability in imaging because of differences in device type, patient size, and tumour characteristics. Furthermore, there are few annotated datasets, and the lack of definition in CNN models may hinder reliability, especially in clinical settings. Where access to advanced imaging technologies is limited, brain tumours' are more severe in foetuses and in infants, CNN-based automated diagnostic systems may provide an effective solution, allowing for early diagnosis and treatment careful planning, especially in underdeveloped areas.

Traditional prenatal screening methods such as ultrasound often fail to detect early-stage fetal brain tumours' due to limitations in image quality and operator variability, delayed or missed diagnosis We deep using Convolutional Neural Networks (CNNs) for automated and accurate detection of fetal brain tumours from prenatal imaging Let us propose a solution-based study on suggestions. Using advanced methods of data enhancement, multi-scale feature extraction, attention mechanisms, and transfer learning, the method aims to increase detection sensitivity and reduce false detection This framework for decision making strong support system for early intervention, so that fetal and maternal outcome There is improvement.

II. RELATED WORK

The paper provides a comprehensive review of infantile brain tumours, highlighting their rarity, unique biological behaviour, and challenges in their diagnosis and treatment. Through a systematic review of the literature from 1980 to 2020, the authors examined data on epidemiology, histology, diagnosis, treatment, and molecular characterization to increase diagnostic accuracy. The study emphasizes the importance of molecular profiling for targeted therapy development, providing insights into molecular mechanisms and potential drug targets. Although the study highlights the critical need for alternative biological control mechanisms, it notes that these tumours are limited by their rarity and the lack of experimental validation of proposed solutions. Despite these limitations, the study is a valuable contribution, advancing the understanding of infantile brain tumours and laying a foundation for future research aimed at improving clinical outcomes. [1]

This study proposes a machine learning algorithm using TensorFlow to detect fetal brain tumors from MRI and ultrasound images. The system focuses on non-invasive diagnostic features, enables early diagnosis without tumor classification during pregnancy, and improves the accuracy and speed of prenatal care Current challenges some include limited information, reliance on alcohol interpretation, and complexity in fetal brain anatomy. Existing methods focus on the distribution of postpartum tumors, differentiating early pregnancy diagnosis. In addition, the high cost and limited availability of MRI emphasizes the need for ultrasound combination. This review aims to fill these gaps, improve screening accuracy, and advance AI-enabled prenatal health care solutions.[2]

This study explores the use of deep learning techniques, specifically recurrent neural networks (RNNs), to provide early detection of brain tumours in infants using ultrasound imaging. The goal is to offer an accessible, non-invasive, and accurate diagnostic tool compared to traditional imaging techniques such as MRI. While promising, this approach faces inherent challenges in ultrasound imaging, such as relatively low sensitivity and difficulty in clearly defining tumour boundaries compared with MRI. Furthermore, current deep learning models, especially RNNs, are not well-suited to analyse static ultrasound images, limiting their effectiveness. Further research is needed to address this gap, improve data quality, enhance feature extraction processes, and explore combinations of different imaging techniques to achieve optimal diagnostic performance.[3]

The study highlights the need for tailored strategies for preterm infants that effectively prevent pain while minimizing adverse effects on brain development. There is a lack of consensus on best practices for managing pain in early brain and little research on how these strategies affect specific brain regions This highlights the need for further research to formulate guidelines clarity and understanding of the impact of pain management on brain development.[4]

The paper proposes a recursive deep neural network for deformation registration of infant brain MR images, using brain tissue separation maps instead of complex images to calculate rapid changes in contrast during infancy inside is calculated the network is trained once and reused during inference to gradually recover strong pathological regions. Although this approach improves accuracy, further research is needed to increase computational efficiency and real-time processing. In addition, the specificity of the technique in infant brain MR images suggests adaptation for wider applications, such as adult brain registration or other medical imaging tasks The dynamics of brain development in infancy add complexity, suggesting potential areas for future investigation.[5]

III. WORKING METHODOLOGY

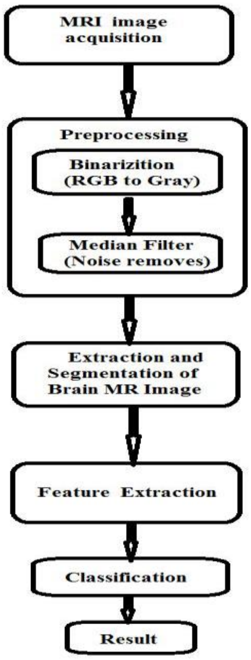

Figure1: Architecture design

The work begins with obtaining magnetic resonance imaging (MRI) and ultrasound images of the brain. These images serve as the basis for research, allowing the study of brain tumours and other abnormalities. MRI and ultrasound are preferred imaging modalities because of their ability to provide detailed anatomical information and detect abnormalities at an early stage When a variety of data is collected, analysis ensures that the system can be very sensitive to a variety of cases, and increases the reliability of analytical processes Classified.

The stored images have a preprocessing pipeline to ensure the best quality for analysis. Initially, images are converted from RGB to grayscale, which simplifies the data and reduces computational complexity. A medium filter is used to remove noise, resulting in a clearer and better image quality. The preprocessing stage also includes partitioning the brain area in order to isolate the area of interest, and ensure that the system focuses on the correct features. These features such as texture, strength, color and shape are then extracted and used for classification. The Convolutional Neural Network (CNN) processes the extracted features to determine whether the brain image shows a normal state or not. The results provide a clearer classification, contribute to the final diagnosis and provide health care providers with a reliable tool for early detection of brain tumours

IV. TECHNICAL SPECIFICATION AND CONFIGURATION

Technical Specification

The developed system uses advanced deep learning and MRI imaging to detect brain tumours in foetus and infants. The preprocessing pipeline includes grayscale adjustment, noise reduction by using a medium filter, and image resizing to ensure high quality input data for analysis Flask is the backbone of the system infrastructure, manages preprocessing performance, manages CNN the trained model is handled and produces results. APIs developed to facilitate seamless interaction between the user interface and the background, enabling real-time or near-realistic analysis of uploaded MRI images The web-based interface developed using Flask or Django Diagnosis for clinicians and researchers to better diagnose brain tumours with a platform that is simple and easy to develop provides

Configuration

The Convolutional Neural Network (CNN) model was optimized using fine-tuning parameters such as batch size, number of studies, and epochs to ensure efficient training, reduced overfitting, and greater accuracy. The software stack includes Python for programming, TensorFlow and Keras for model development, and OpenCV for image preprocessing. Performance metrics such as accuracy, precision, recall, and F1-score were evaluated to determine the efficiency of the model. The scalable and reliable design of the system makes it suitable for real clinical use, enabling early tumour detection and improving health outcomes from antenatal and pediatric care.

V. RESULTS

Fig 1. Home page

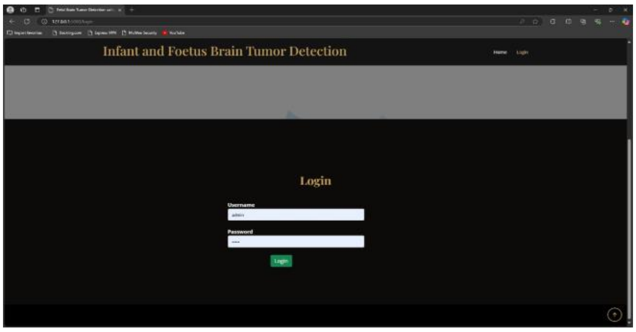

Fig 2. Login page

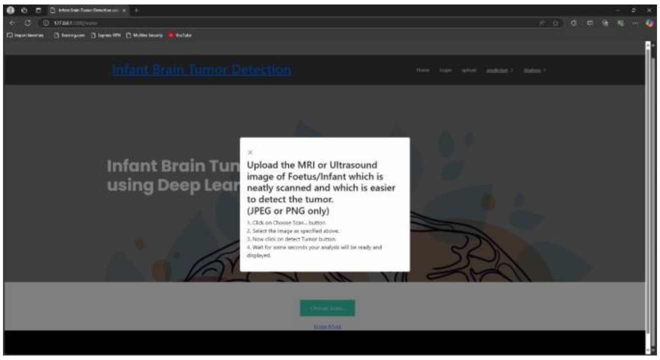

Fig 3. Uploading JPEG or PNG image

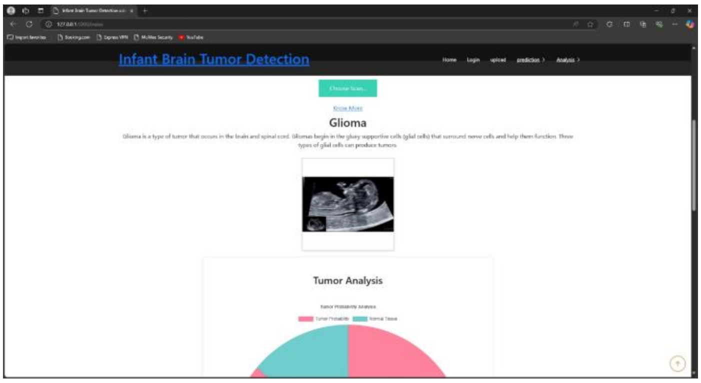

Fig 4. Glioma Tumour detection

Gliomas are a group of tumors that arise from glial cells in the central nervous system (brain and spinal cord). Glial cells support and protect the brain's nerve cells (also called neurons). They hold nerve cells in place, bring food and oxygen to nerve cells, and help protect nerve cells from disease, such as infection. Gliomas can form in any area of the CNS and can be low grade or high grade.[10]

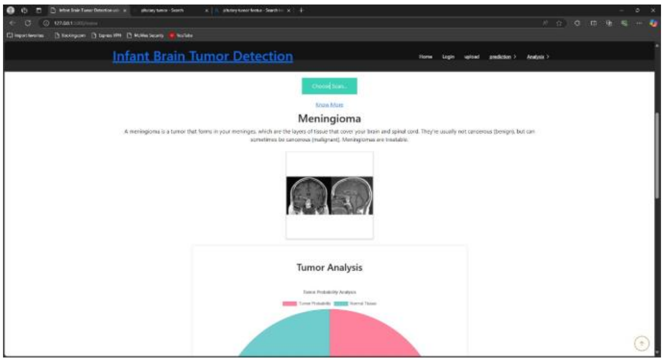

Fig 5. Meningioma Tumour detection

Meningiomas during pregnancy, though rare, pose risks to both mother and fetus. Management requires a multidisciplinary approach, considering tumor size, symptoms, gestational age, and fetal health, with further research needed.[9]

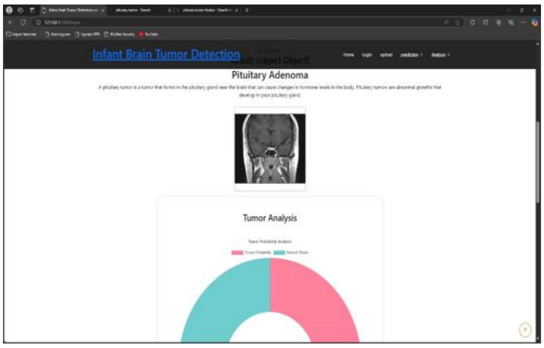

Fig 6. Pituitary Tumour detection

The pituitary gland regulates hormones essential for reproduction and growth. Untreated pituitary tumors during pregnancy can cause headaches, visual disturbances, or require treatment, though most cases remain asymptomatic and manageable.[8]

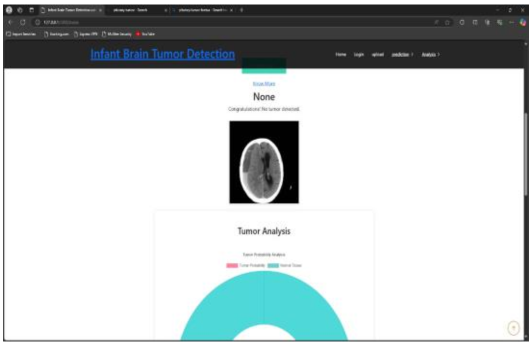

Fig 7. No Tumour Detection

There is no tumour detected hence the foetus or infant is safe.

The developed system demonstrated high accuracy in identifying and classifying fetal and infant brain tumours using MRI images. Convolutional neural networks (CNN) have successfully identified a variety of tumours, including gliomas, meningiomas, pituitary tumours, or even the absence of tumours. Through rigorous training and testing, the model achieved important performance metrics, including precision, recall, and F1 scores, which increased its reliability Preprocessing pipeline ensured consistent input data good, enhanced the model's ability to focus on important features for classification. The assessment was facilitated, by health professionals who provided a simple and effective way to do so. These results highlight the potential of deep learning to improve early detection and outcomes in prenatal care and child care.

VI. CONCLUSION

This project has successfully developed an improved system for the detection of brain tumours in infants and foetuses using MRI and ultrasound imaging. Focusing on early unclassified detection, the system enhances the Detection capability with an essential tool for prenatal and neonatal abnormality detection through systematic image a advance the combination of real-time diagnostic techniques using MRI and ultrasound. This approach aims to help health care providers detect brain tumours at an early stage, potentially improving clinical outcomes and reducing risks for vulnerable populations Future work may require imaging techniques new will integrate and optimize for increased accuracy and performance in clinical settings.

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