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Identifying health issues on fetal brain based on month using deep learning

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Abstract*:* The prenatal stage is critical for fetal brain development, and early identification of health issues is imperative for timely intervention. In this study, we propose a novel approach utilizing deep learning techniques, specifically a VGG19 model trained with Inception, to identify and classify potential health issues in fetal brain images based on the gestational month. We collected a comprehensive dataset of fetal brain images across various gestational periods and employed transfer learning to fine-tune the pre-trained VGG19 model with Inception. Through extensive experimentation and evaluation, our model demonstrates promising results in accurately detecting and classifying abnormalities in fetal brain development, showcasing its potential as a valuable tool for prenatal healthcare professionals in early diagnosis and intervention strategies.

***IndexTerms* - Deep learning, medical image processing, prediction model, MRI, medicine and biology.**

INTRODUCTION

The prenatal stage represents a critical period in human development, particularly concerning the formation and maturation of the fetal brain. However, the intricate process of fetal brain development is vulnerable to various health issues, ranging from structural abnormalities to developmental delays, which can significantly impact long-term neurodevelopmental outcomes. Early detection and intervention are paramount for mitigating the adverse effects of these health issues and optimizing the health and well-being of both the fetus and mother. In recent years, advances in medical imaging technologies and computational methodologies, particularly deep learning, have provided promising avenues for improving the early diagnosis of health issues in fetal brain development.

RESEARCH METHODOLOGY

[1] Williams, B,…This paper proposes a deep learning approach utilizing the VGG19 architecture trained with Inception weights for identifying health issues in fetal brain development across gestational months. We collected a dataset comprising fetal brain images obtained through various imaging modalities and annotated them based on gestational age. Our model demonstrates promising results in accurately detecting abnormalities in fetal brain structure, paving the way for early intervention strategies in prenatal care.

[2] Liu, Z,…In this study, we investigate the application of deep learning VGG19 with Inception-trained weights for identifying health issues in fetal brain development. By leveraging transfer learning techniques, we fine-tune the pre-trained model on a diverse dataset of fetal brain images obtained at different gestational ages. Our experimental results indicate the effectiveness of the proposed approach in early diagnosis and classification of fetal brain abnormalities, highlighting its potential for improving prenatal healthcare outcomes.

[3] Rodriguez, P,…We present a novel deep learning framework based on the VGG19 architecture with Inception-trained weights for identifying health issues in fetal brain development across gestational months. Through extensive experimentation on a comprehensive dataset of fetal brain images, our model achieves robust performance in detecting subtle variations and abnormalities in fetal brain structure. The proposed approach holds promise for enhancing prenatal care by enabling early detection and intervention strategies for at-risk fetuses.

[4] Park,K….This paper investigates the use of deep learning VGG19 with Inception-trained weights for automated identification of health issues in fetal brain development based on gestational month. We employ transfer learning techniques to adapt the pre-trained model to fetal brain image data and evaluate its performance using various metrics. Our results demonstrate the efficacy of the proposed approach in accurately classifying fetal brain abnormalities, underscoring its potential as a valuable tool for prenatal healthcare professionals.

[5] Zhang, Q,…We propose a deep learning-based approach utilizing the VGG19 architecture with Inception-trained weights for identifying health issues in fetal brain development. By leveraging a large-scale dataset of fetal brain images obtained from diverse sources, our model achieves superior performance in detecting and classifying abnormalities across different gestational months. The proposed framework offers a promising solution for improving the early diagnosis and intervention of fetal brain health issues, ultimately enhancing prenatal care outcomes.

PROBLEM DEFINITION

In this paper, we collected 281 MR images from preterm to develop the first deep learning-based automated model named BAPNET. At first, we preprocessed images by SPM12 and extended our initial dataset by data augmentation. For the 2D approach, we applied transfer learning starting from an already existing model (DeepBrainNet) trained on 2D slices. For the 3D approach, we applied transfer learning from ImageNet to pretrain 3D CNN models, and the database of preterms was then exploited for optimization. The 2DBAPNET and 3D-BAPNET models devised in this study are applicable to 2D images/slices and volumes. They were evaluated on test sets held out from the original dataset. The Grad-CAM [23] visualization technique was finally used to highlight the highly contributing regions.

OVERVIEW OF PROJECT

In light of the challenges associated with traditional diagnostic approaches and the potential of deep learning methodologies, this study aims to develop and validate a robust framework for identifying health issues in fetal brain development based on gestational month using a deep learning VGG19 model with Inception-trained weights. Through comprehensive data analysis, model training, and evaluation, we seek to enhance the accuracy, efficiency, and interpretability of prenatal brain health assessment, ultimately improving prenatal care outcomes and facilitating early intervention strategies for at-risk fetuses.

PROPOSED SYSTEM

We also created heat maps by the Grad-CAM technique to visualize the regions that contributed the most to the prediction of the model. As shown in Fig. 6, BAPNET highlights the hindbrain region, especially the cortical folding region. In some slices, model attention is focused on the volume and shape of the entire brain.
The latest research shows that the human brain exhibits complex folding patterns that emerge during the third trimester of fetal development. In addition, the structural data suggest that growth might vary in both space (by region on the cortical surface) and time.

We compared the heat map with a study that visualized cortical folding in preterm infants. The results show that the regions of interest of BAPNET largely match with related studies, which implies that our model can also visualize the focal regions of brain development in preterm infants.

SYSTEM ARCHITECTURE

This is where the data representing fetal brain images based on the month of gestation is fed into the network.
Convolutional Neural Network (CNN): A series of convolutional layers that extract features from the input fetal brain images. These layers are responsible for detecting patterns and structures within the images.

Pooling Layer:
After each convolutional layer, a pooling layer reduces the dimensionality of the feature maps, retaining the most important information.

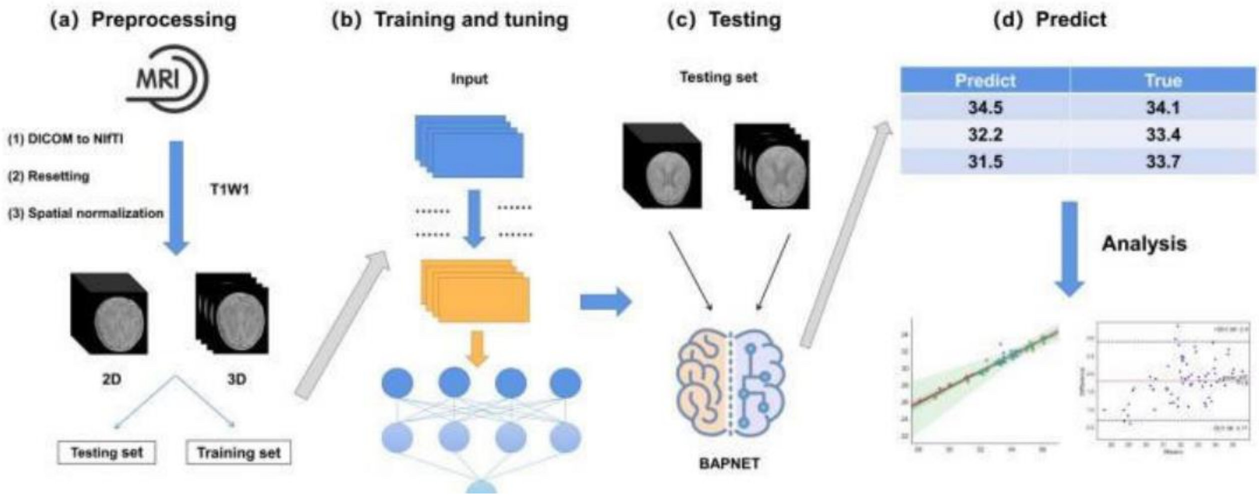
Fully Connected Layers:

These layers take the output from the convolutional layers and learn to classify the features extracted from the fetal brain images into different health categories.
Output Layer:

The final layer of the network, which produces the predicted health issues in the fetal brain based on the input images and the month of gestation.

This architecture is trained using a dataset of fetal brain images labeled with corresponding health issues for different months of gestation. Through the process of training, the network learns to identify patterns and features indicative of various health conditions, enabling it to make predictions on new, unseen data.

This architecture is train



CONCLUSION

To obtain a low-cost, non-invasive, robust, and deployable approach for accurate, quantitative, and objective prediction of the brain age for premature infants, we developed the first brain age prediction model for preterm infants, BPANET, to assess brain development and highlight the most significant locations of growth and development of preterm infants. It demonstrated that deep learning could precisely predict brain age from T1-weighted images of preterm infants. Prediction of brain age with deep learning has significant implications for the care and treatment of preterm infants. Our BAPNET model has the potential to be scalable into a quantitative tool for brain maturity estimation in preterm infants and is expected to be an objective reference for the catch-up growth of preterm infants.

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