Fetal Head Biometrics: Annotation & Deep Learning in Ultrasound Images

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Abstract

The research aims to improve automated fetal head biometric identification in ultrasound images using large-scale annotation and deep learning techniques. By leveraging public datasets, the study investigates AI models for fetal health problems, extracts biometric measurements for age and weight prediction, and explores composite image techniques for enhancing fetal head segmentation. The research also involves annotating a large-scale dataset for various computer vision tasks and developing a "one vs all" deep learning approach for accurate segmentation of fetal brain, Cavum septi pellucidi (CSP), and lateral ventricles (LV).

Keywords: fetal ultrasound, biometric identification, deep learning, large-scale annotation.

Introduction

Automated fetal head biometric identification in ultrasound images plays a crucial role in assessing fetal health and development. However, current techniques often rely on manual measurements, which can be time-consuming, error-prone, and subject to inter-observer variability. Additionally, the limited availability of annotated datasets and challenges in image segmentation contribute to the issues in fetal ultrasound analysis. By applying large-scale annotation and deep learning, it is possible to enhance the accuracy and efficiency of fetal head biometry in ultrasound images. This advancement in technology has the potential to revolutionize prenatal care, leading to improved fetal health assessment and providing better support for healthcare professionals in their decision-making processes.

Materials & Methods

- Utilize public fetal head ultrasound datasets
- Apply deep learning techniques for fetal head segmentation
- Use machine learning algorithms for age and weight prediction
- Investigate 35 image processing techniques for composite image creation
- Enhance fetal head segmentation with composite images
- Preprocess images for large-scale dataset annotation
- Convert pixel measurements to millimeters
- Annotate computer vision tasks (fetal brain, CSP, LV)
- Develop deep learning models for each class
- Train models on respective datasets
- Combine models for final prediction

Results 2

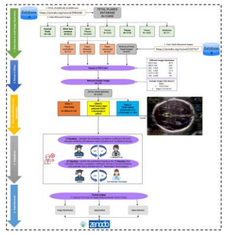

Figure 5: Large scale dataset

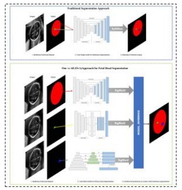

Figure 6: Fetal Brain CSP and LV segmentation

Results 1

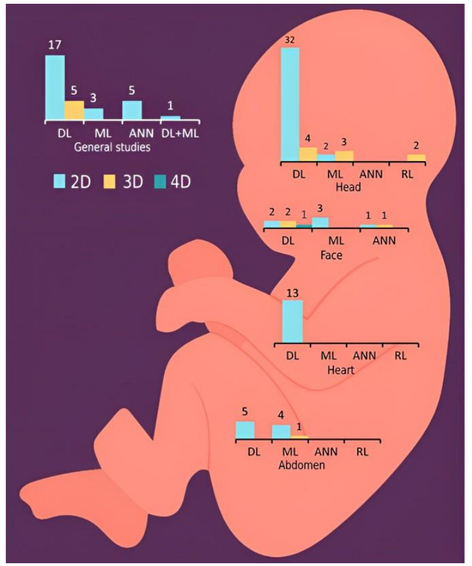

Figure 1: AI usage for Fetal Ultrasound images

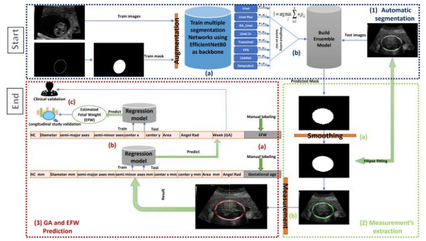

Figure 2: Framework to predict age and weight

	Fetal GA Prediction in the 50th Percentile (13 > GA > 25) Week		EFW Prediction in the 50th Percentile (20 > GA > 36) Week	
Regression model	MSE	Pearson's r	MSE	Pearson's r
Polynomial Regression	**0.00033**	**0.9958**	9.08723	0.9422
Linear Regression	0.00205	0.9899	**0.00035**	**0.9988**
Random Forest Regressor	0.00842	0.9511	6.54380	0.9844
XGBRFRegressor	0.02268	0.9505	**0.00018**	0.9847
Neural network	0.01392	0.9805	0.00256	0.9946
KNeighbors Regressor	0.00921	0.9582	0.00214	0.9841
SGDRegressor	0.00219	0.9901	0.00146	0.9968
AdaBoostRegressor	0.01086	0.9505	0.00100	0.9843
BaggingRegressor	0.01081	0.9832	0.00281	0.9964
StackingRegressor	0.00824	0.9506	6.93890	0.9843
LinearSVR	0.00199	0.9901	**0.00054**	**0.9989**
LGBMRegressor	0.01011	0.9514	7.72867	0.9843
Lasso	0.08300	NA	0.17339	0.8507
VotingRegressor	0.00248	0.9909	0.00031	0.8507
BayesianRidge	0.00206	0.9899	0.00035	0.9988
Deep NN	**0.00072**	**0.9978**	0.00068	NA

Figure 3: Fetal age and weight prediction

Conclusion

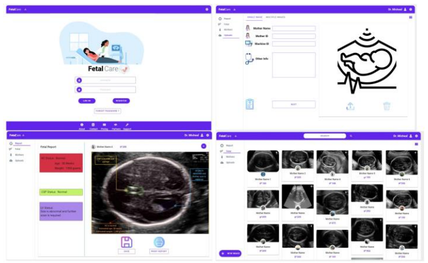

Figure 4: System Demo

This research advances fetal head biometric identification in ultrasound images through large-scale annotation and deep learning optimization. By reviewing existing AI applications, estimating fetal age and weight, enhancing segmentation techniques, and developing a "one vs all" deep learning approach, we significantly improve the accuracy of biometric identification. This work contributes to the field and has the potential to enhance prenatal care and early diagnosis of fetal health issues.

References

1 Alzubaidi et al. artificial intelligence techniques to monitor fetus via ultrasound images. *Iscience*, 2022.

2 Alzubaidi et al. From segmentation to gestational age and weight prediction. *Diagnostics*, 2022.

Future Research

Future work will focus on expanding R&D research to deal with ultrasound videos for developing a comprehensive fetal analysis system, as demonstrated in our preliminary demo.

DL and real-time processing techniques, we aim to create a robust system capable of performing accurate fetal health assessments and facilitating more informed clinical decisions throughout pregnancy.

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