Automated Measurement of Fetal Head Circumference using ESPNet Regression

Le Quoc Trung – BA12-177

***Abstract*—This study focuses on implementing an ESPNet-based regression model for the automated measurement of fetal head circumference using 2D ultrasound images. This method directly predicts the elliptical parameters representing the head boundary.**

I. Introduction

This study focuses on implementing an ESPNet-based regression model for the automated measurement of fetal head circumference using 2D ultrasound images. This method directly predicts the elliptical parameters representing the head boundary.

II. Data Analysis

The dataset used in this study is the HC18 dataset, containing 999 2D ultrasound images of fetal heads with corresponding ground truth annotations for training and 335 unannotated test images. The dataset is split into 80% training, 10% validation, and 10% testing to evaluate model performance.

To further analyze the dataset, three sample images are presented below:

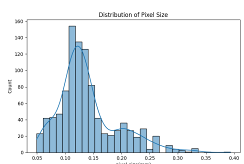


Fig. 1: Distribution of Pixel Size

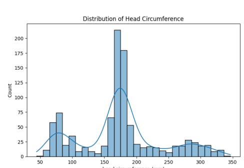


Fig. 2: Distribution of Head Circumference

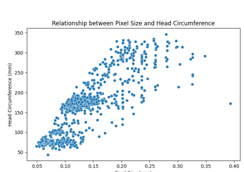


Fig. 3: Relationship between Pixel Size and Head Circumference

III. Model

Instead of performing segmentation, the ESPNet-based model is designed to predict the parameters of an ellipse that best fits the fetal head boundary. The model outputs five continuous values corresponding to the ellipse's center coordinates (x, y), semi-major axis (a), semi-minor axis (b), and rotation angle (θ).

A. ESPNet Architecture

The ESPNet model follows a lightweight encoder-decoder structure:

- **Encoder**: Multiple convolutional layers with depthwise separable convolutions to extract features efficiently.
- **Decoder**: Fully connected layers to predict five continuous parameters representing the elliptical head boundary.

B. Loss Function

The model is trained using Mean Squared Error (MSE) loss, as the task requires continuous numerical prediction. The Adam optimizer is used to ensure stable convergence.

IV. Results

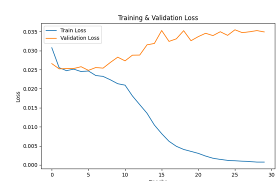


Fig. 4: Training and Validation Loss

A. Head Boundary Prediction

The ESPNet model is trained for 30 epochs, and the performance is evaluated using Mean Absolute Error (MAE) and Intersection over Union (IoU) between the predicted and ground truth ellipses. The table below summarizes the results:

Metric	MAE	IoU
ESPNet	0.0152	0.5123

TABLE I: Performance Metrics of the ESPNet Model

B. Test Examples

The following figures represent 5 test examples from the dataset: article graphicx

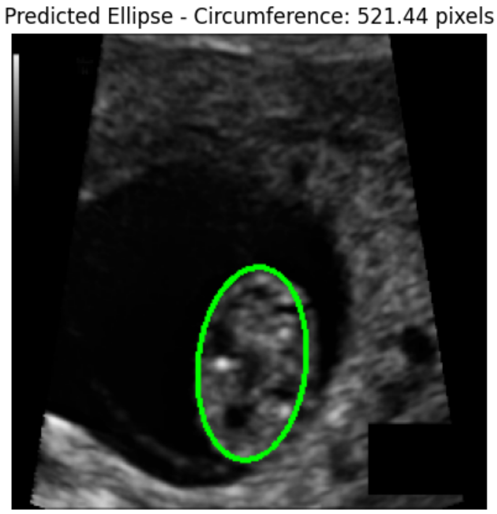


Fig. 5: Test Example

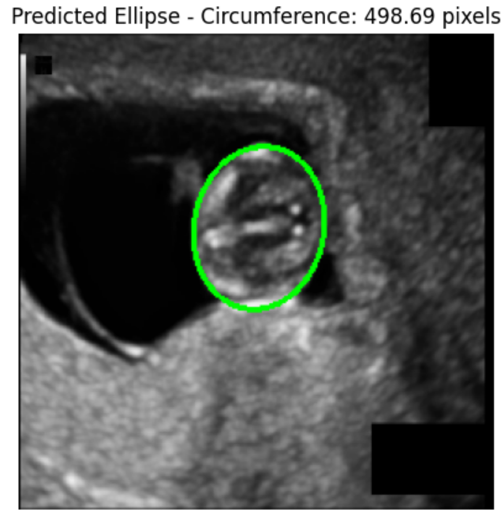


Fig. 6: Test Example

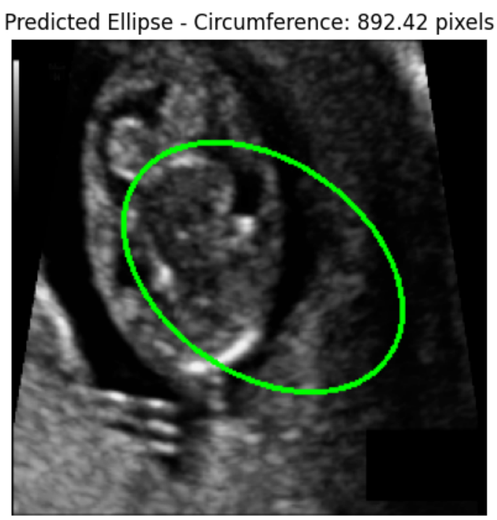


Fig. 7: Test Example

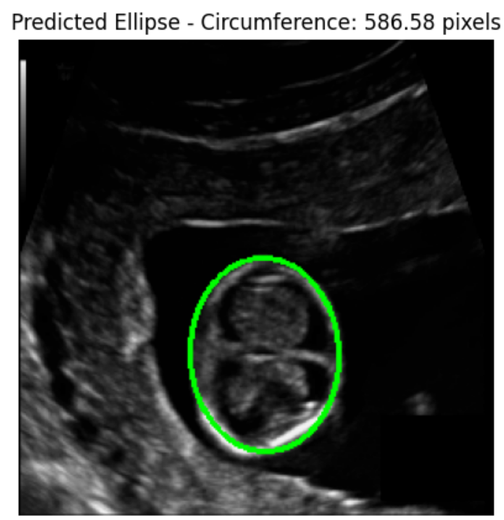
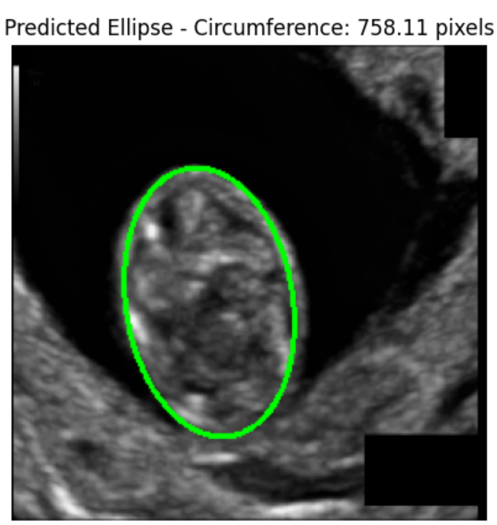


Fig. 8: Test Example



V. Conclusion

The ESPNet model effectively predicts fetal head boundaries by estimating ellipse parameters, reducing post-processing complexity. Further improvements could enhance accuracy by incorporating advanced loss functions like IoU loss and MSE.