

Practical Work 2: Measurement of Fetal Head Circumference

I. INTRODUCTION

Fetal Head Circumference (HC) is a key biometric parameter for monitoring fetal growth. Automating this measurement using regression models can assist sonographers. We employ a pre-trained ResNet18 model and fine-tune it for the regression task.

II. DATASET AND PREPROCESSING

A. Dataset Description

The dataset used in this study is obtained from the HC18 Grand Challenge. It comprises a total of 1,334 2D fetal ultrasound images, officially divided into a training set of 999 images and a test set of 335 images.

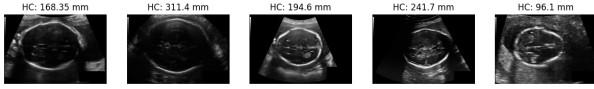


Fig. 1. Sample 2D ultrasound images from the HC18 dataset.

The dataset covers various stages of fetal development, with Head Circumference (HC) values ranging from a minimum of 44.3 mm to a maximum of 346.4 mm.

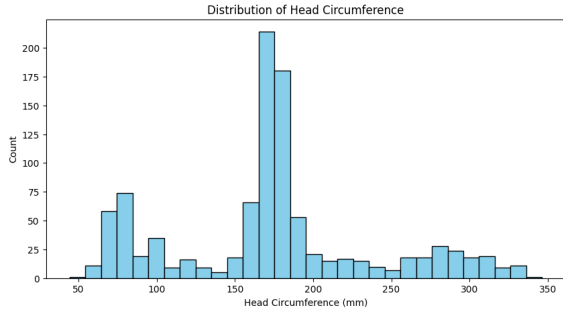


Fig. 2. Data distribution of the training set.

B. Preprocessing

Due to the lack of ground truth in the test set, we split the training data into an 80% training set and a 20% validation set for evaluation. Images are resized to 224×224 pixels and normalized using ImageNet statistics. To improve generalization and prevent overfitting, we applied data augmentation techniques such as Random Horizontal Flip and Random Rotation ($\pm 10^\circ$).

III. METHODOLOGY

A. Model Architecture

We utilized the ResNet18 architecture. The final Fully Connected layer was modified to output a single continuous value (HC in mm). The Mean Squared Error (MSE) is used as the loss function.

B. Training Strategy

We performed hyperparameter tuning with three main configurations:

- **Baseline:** Adam optimizer with low learning rate (10^{-4}).
- **Scheduler:** Adam (10^{-3}) with ReduceLROnPlateau.
- **Momentum:** SGD (10^{-4}) with Momentum 0.9.

Early Stopping (Patience=5) was implemented to determine the optimal number of epochs.

IV. EXPERIMENTS AND RESULTS

We compared the three optimization strategies. The results are summarized in Table I.

TABLE I
COMPARISON OF OPTIMIZATION STRATEGIES

Optimizer	Learning Rate	Batch Size	Best Val MAE (mm)
Adam	10^{-4}	32	139.21
Adam + Scheduler	10^{-3}	32	13.66
SGD	10^{-4}	32	10.97

SGD (10^{-4}) combined with momentum proved to be the most effective optimizer, achieving the lowest error. It offered more stable learning compared to Adam, leading to better generalization on the validation set.

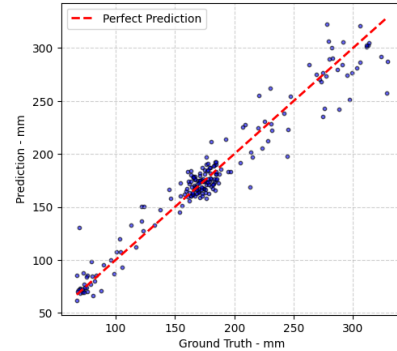


Fig. 3. Scatter plot of Ground Truth vs. Predicted HC using SGD optimizer

Figure 3 illustrates the correlation between the Ground Truth and Predicted HC values for the best model (SGD). The data points cluster tightly around the diagonal line, indicating high prediction accuracy.

V. CONCLUSION

The ResNet18 model optimized with SGD proved to be the most effective strategy, achieving a prediction error of 10.97 mm. Future work will explore segmentation-based approaches, such as U-Net, to enable visual verification and further improve measurement accuracy.