OBUS – Estimated Fetal Weight Model Architecture

This document describes the architecture used for the development of the Estimated Fetal Weight model. See the GHL OBUS Github Repository [1] for an instantiation of this architecture along with more detail in its Readme file.

Design considerations

The task of Estimated Fetal Weight estimation is very similar to Gestational Age estimation; both are based on assessing the size of fetal anatomical structures, such as the head, abdomen, and limbs, and using these measurements to predict a quantity that grows as the fetus matures. It stands to reason that a model architecture similar to the one used for gestational age estimation should work for fetal weight estimation (see [1.2 Gestational Age Model Architectures]).

While the similarities between the two tasks are valid and might suggest that identical architecture be used, a design decision was made to compute fetal weight using a multi-task approach. Rather than directly predict the fetal weight from the blind sweep videos, it was decided that the model should predict the biometric measurements and use the predicted biometric values in an established formula, e.g., the 4-component Hadlock formula [2], to predict the estimated fetal weight. There are a few advantages to this approach.

- **Interpretability**: The biometric model is more interpretable than the direct model, because the biometric measurements that it is predicting are understood intuitively by practitioners. If the EFW prediction is inaccurate, it can be traced to one or more inaccurate biometric predictions.
- **Flexibility**: By a judicious change of the formula used to estimate fetal weight, the model can be localized to a specific region or population without the need to collect more data, annotate it, and retrain the model.
- **Performance**: It was found that the biometric prediction model performed slightly better than the direct prediction model. We believe this can be explained by the observation that it is harder for the biometric model to “cheat” because it has to predict four intermediate quantities instead of just the final answer.

Model Architectures

Although the biometric fetal weight estimation model works with the same overall architecture as the gestational age model (except for the substitution of a four node fully connected layer at the end) it was found that a slight modification of the temporal aggregation layer gave improved results as explained below.

The EFW model follows the **Spatial → Temporal aggregation → Regressor** pipeline, with specific choices for the spatial and temporal components.

- **Spatial:** MobileNet_V2 was selected as the backbone architecture, since it provided excellent performance and fast throughput.
- **Temporal:** A Multiple Additive Attention (MAA) model was chosen for the temporal aggregation module. This model uses multiple Basic Additive Attention (BAA) [3] layers (say, M of them) and concatentates them to provide a context vector that is M times the length of any one of them. We surmise that each attention layer can focus attention on different features in the image, thus increasing the predictive power of the model overall. Just like BAA, the MAA model is frame-order agnostic.
- **Regressor:** The regressor is a fully connected layer with a linear activation function, trained to output four numeric values corresponding to the z-scaled-log of biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). The output biometric predictions are then rescaled to physical units and fed to a Hadlock formula to compute the estimated fetal weight.

The model architecture block diagram is shown in Figure 1.

Training

This model may be trained on the video-level, but memory and batch considerations dictate that a fixed number of frames be sampled (*e.g.*, randomly) during training. At inference time, however, all frames of all videos in an exam are concatenated and evaluated.

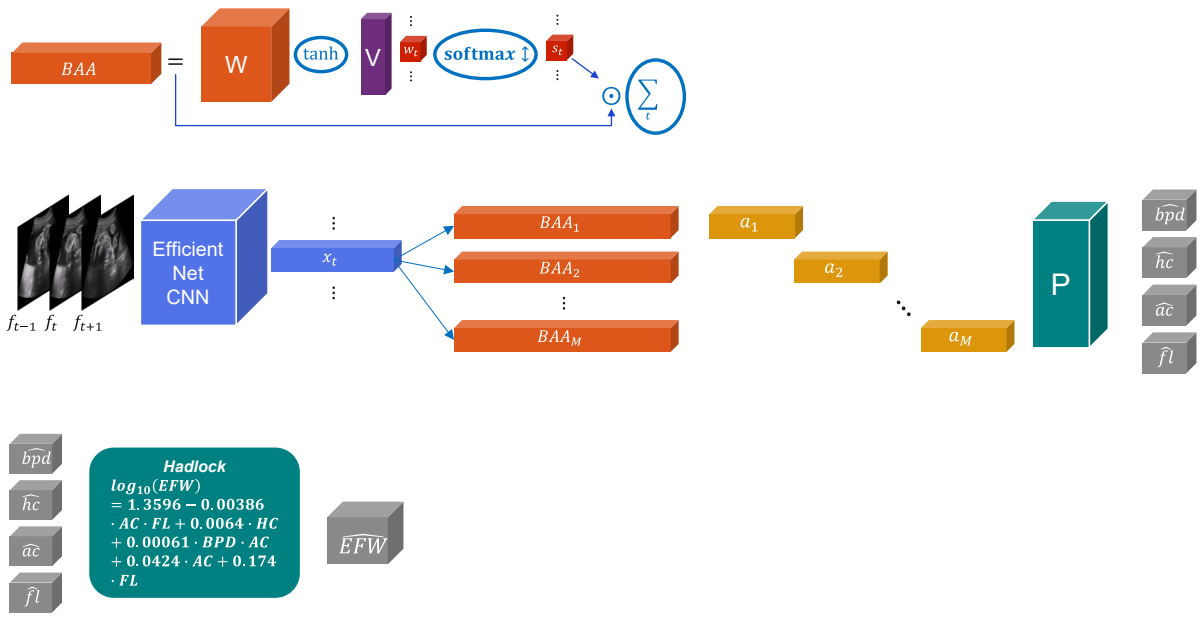

Figure 1. CNN → MAA → Regressor architecture for fetal weight estimation.

References

[1] "GHL OBUS GitHub Repository," 2025. [Online]. Available: https://github.com/Global-Health-Labs/OBUS-GHL-DEV.

[2] F. Hadlock, R. Harrist, R. Sharman, R. Deter and S. Park, "Estimation of fetal weight with the use of head, body, and femur measurements—A prospective study," *Am. J. Obs. & Gyn.,* vol. 151, no. 3, pp. 333-337, 1985.

[3] D. Bahdanau, J. Chorowski, D. Serdyuk, P. Brakel and Y. Bengio, "End-to-end attention-based large vocabulary speech recognition," *arXiv:1508.04395v2,* 2016.