

Quantitative assessment of fetal breathing movements and multivariate time-series analysis using a Transformer

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BACKGROUND & OBJECTIVE

- Fetal breathing movements (FBM) are a component of the biophysical profile and reflect fetal well-being.
- Conventional ultrasound assessment is observer-dependent and does not readily quantify breathing, fetal movement, and heart rate simultaneously.
- Objective:** To quantify FBM continuously from fetal ultrasound video and perform multivariate time-series analysis with fetal movement and heart rate using a Transformer.

METHODS

STUDY COHORT

100
videos

24–36
weeks

10 s
clips

50 frames
@ 5 fps

- Sagittal fetal ultrasound videos acquired July–December 2025 were analysed in 10-second sets.
- Per-frame annotations:** diaphragm apex, insertion points, trunk reference point, and cardiac chamber pulsation.
- Spatial calibration used the 1-cm scale marker.
- Derived signals:** FBM displacement (cm), fetal movement index from trunk displacement, and estimated fetal heart rate.
- The three synchronized signals were used as multivariate time-series features for a Transformer Encoder predicting FBM displacement.

SIGNAL DEFINITIONS

● FBM displacement

Diaphragm excursion, calibrated in cm

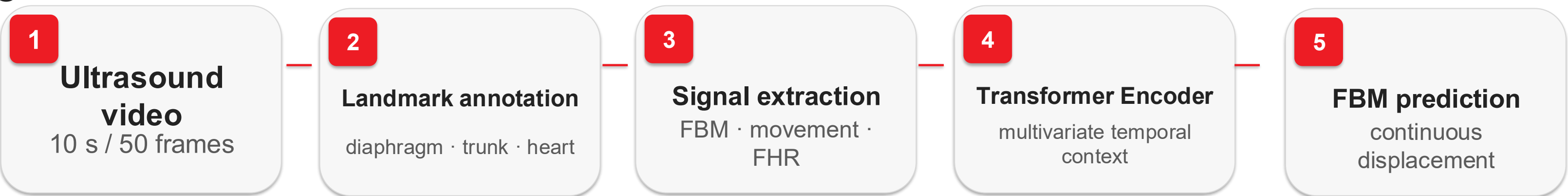
● Fetal movement index

Trunk displacement on the same time axis

● Estimated FHR

Derived from annotated cardiac chamber pulsation

ANALYTIC WORKFLOW



RESULTS

BEST TEST REGRESSION LOSS

0.83

Stable performance was observed from early training epochs.

- The best model tracked temporal changes in FBM displacement and preserved the overall breathing-movement trend.
- Synchronizing fetal movement and estimated FHR on a common time axis enabled visual assessment of their relationship with FBM.

FROM VISUAL SCORING TO CONTINUOUS PHYSIOLOGY

The framework converts a short ultrasound clip into synchronized, quantitative physiological trajectories—FBM, fetal movement, and estimated heart rate—suitable for temporal AI analysis.

CONCLUSIONS

Continuous FBM displacement can be quantified from fetal ultrasound video and analysed jointly with fetal movement and heart rate using a Transformer. This supports a more objective and reproducible framework for fetal well-being assessment.

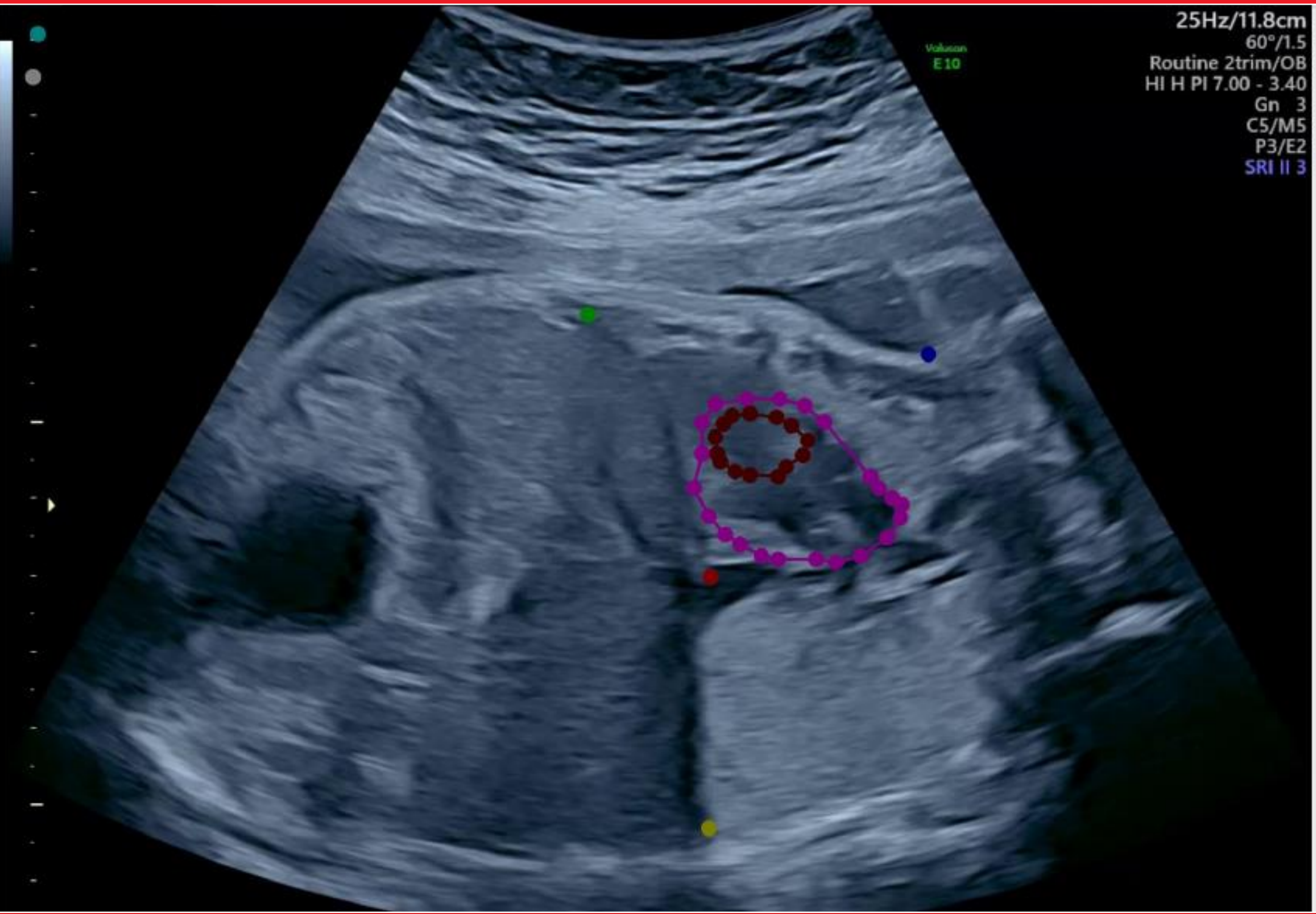
NEXT STEPS

- Expand the dataset for robust model development and external validation.
- Establish gestational-age-specific reference patterns and evaluate fetal growth restriction.
- Integrate CTG and fetal cardiac function toward multimodal fetal assessment.

STUDY AT A GLANCE

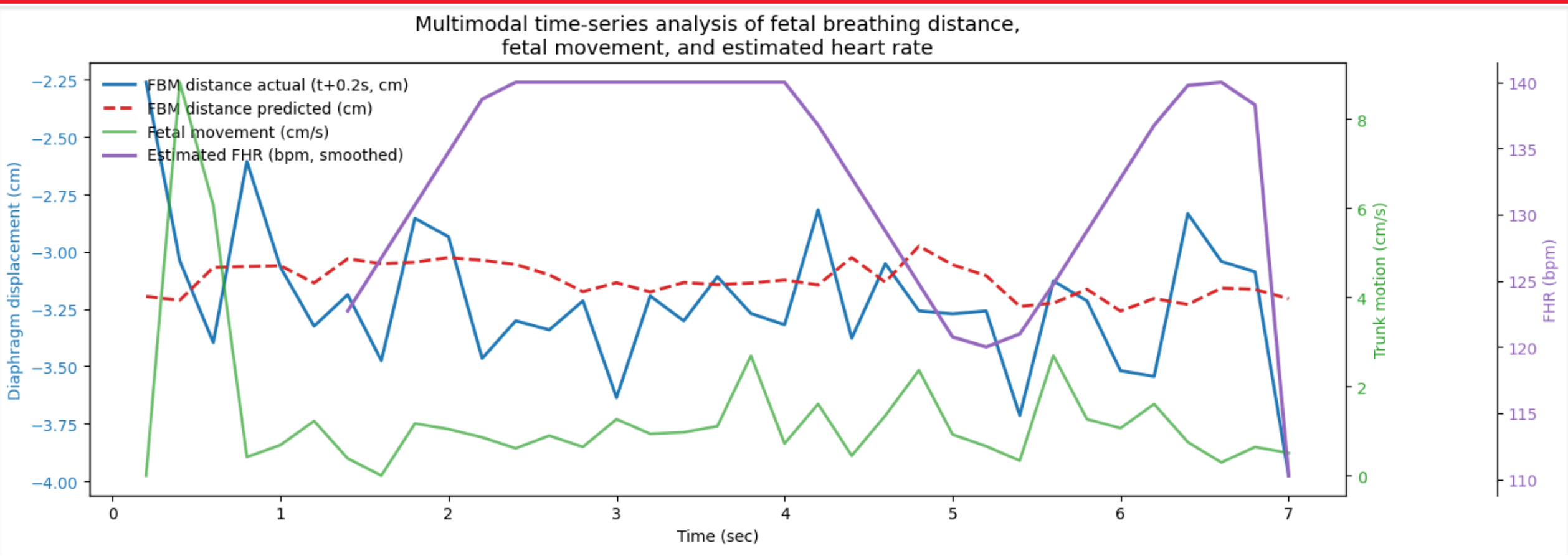
N = 100 ultrasound videos	24–36 w gestational age
50 frames / 10 s	0.83 best test loss

Figure 1. Frame-level annotation



Annotated diaphragm, trunk, and cardiac landmarks were converted into synchronized physiological signals.

Figure 2. Representative multivariate time series



Observed and predicted FBM displacement are shown together with fetal movement and estimated FHR on a common time axis.

KEY MESSAGE

A short fetal ultrasound video can be transformed into continuous, multimodal physiological data for Transformer-based temporal analysis.