

EP08.06

Anatomical continuity-aware 3D reconstruction of the cardiovascular structures to support fetal cardiac ultrasound screening

Naoaki Harada, Institute of Science Tokyo, Japan

Introduction

- Prenatal screening for congenital heart disease requires assessment of cardiac anatomy beyond the four-chamber view, particularly the ventricular outflow tracts and great-artery connections.
- This is essential for detecting abnormalities such as dextro-transposition of the great arteries (d-TGA), as shown in Figure 1.

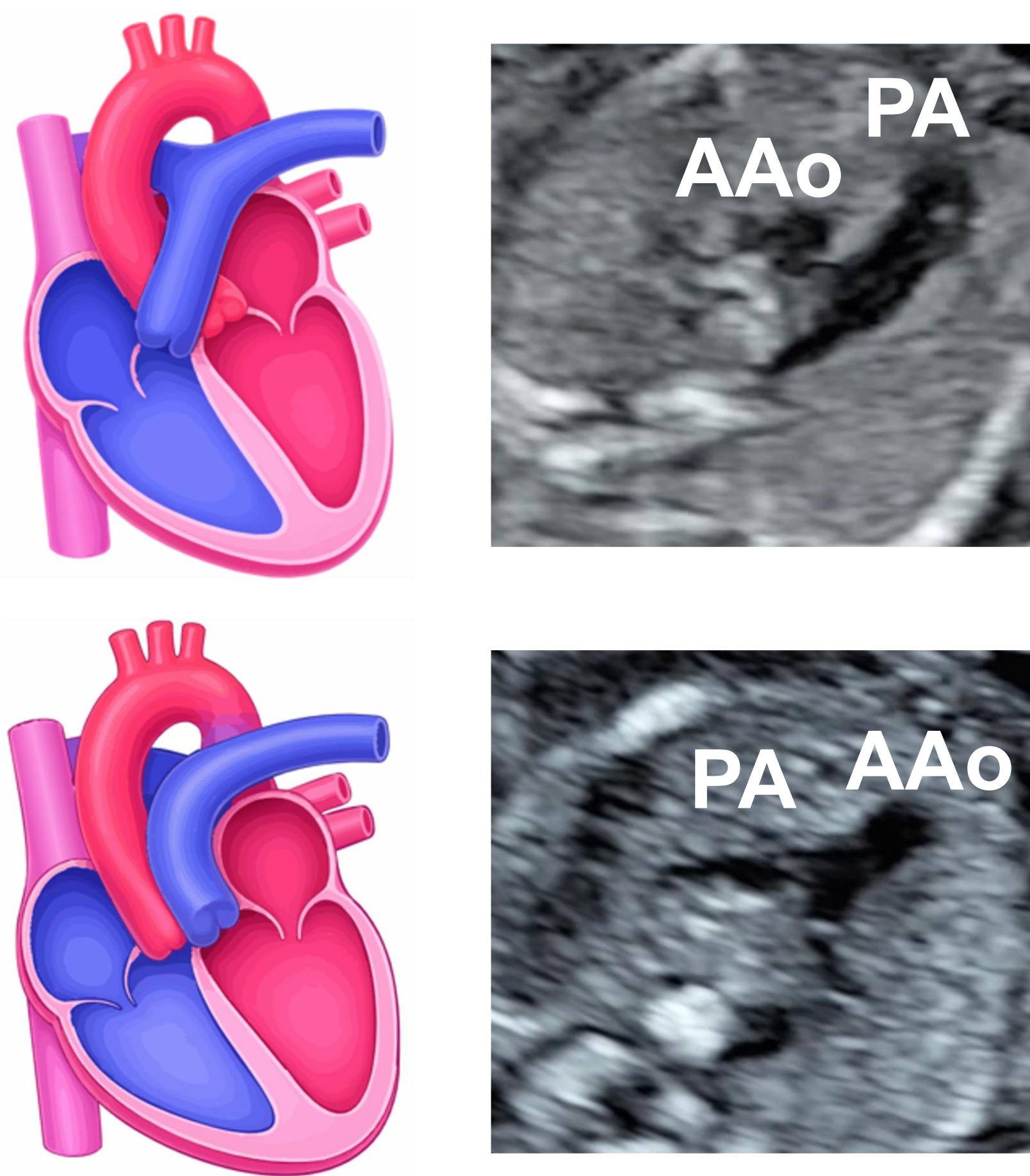


Figure 1. Healthy Heart (upper) vs d-TGA Heart (lower)

Why 3D anatomy matters

3D anatomy shows whether the great arteries cross normally or run in parallel, as in d-TGA — a relationship difficult to determine from a single 2D image.

Objectives

- Most existing AI methods rely on individual 2D images, while 3D analysis of fetal cardiac ultrasound remains underdeveloped.
- We therefore aimed to develop an AI framework for 3D reconstruction and analysis of fetal cardiovascular structures from ultrasound sweep videos as shown in Figure 2.

Methods

- A pseudo-3D SwinUNETR with temporal–spatial fusion was trained on 130 cases of sweep videos and independently tested on 30 cases.

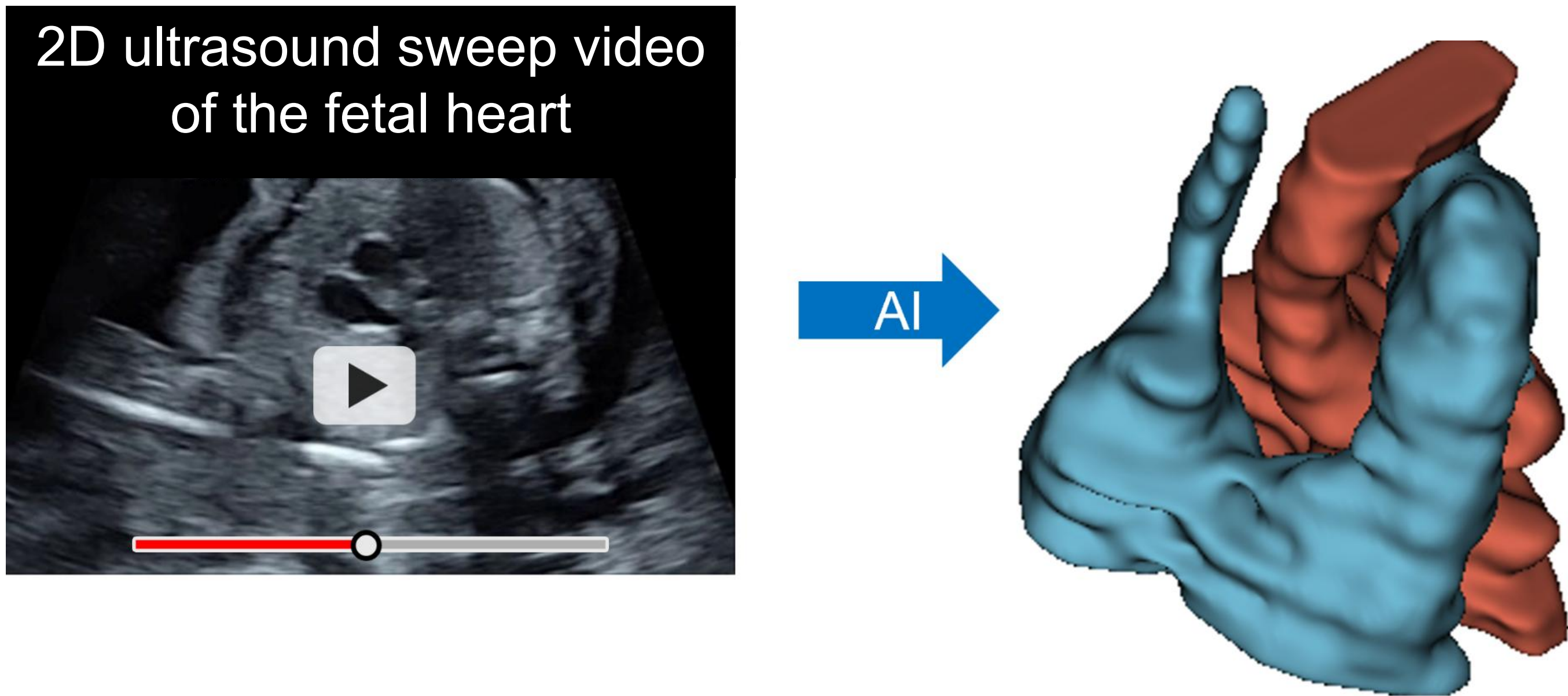


Figure 2. Overview of the proposed AI framework for 3D reconstruction of fetal cardiovascular structures from 2D ultrasound sweep videos.

Results

- The model achieved a surface Dice score of 0.866 on the independent test set.
- Thirteen examiners (5 experts and 8 fellows) assessed fetal cardiac ultrasound videos under two conditions: video alone and video with AI-generated 3D visualization.
- Adding 3D visualization improved overall diagnostic accuracy from 0.779 to 0.808 and significantly increased the confidence-weighted accuracy score from 6.525 to 6.925 ($p = 0.007$).

Examiners	Accuracy		Confidence-Weighted Accuracy Score		
	Video Only	Video + 3D	Video Only	Video + 3D	p value
Overall (n = 13)	0.779	0.808 ↑	6.525	6.925 ↑	0.007
Experts (n = 5)	0.820	0.830	6.770	7.210	0.055
Fellows (n = 8)	0.750	0.793	6.350	6.721	0.068

Conclusion

AI-driven 3D cardiovascular visualization of fetal cardiovascular structures from 2D ultrasound sweep videos has the potential to support examiners and facilitate fetal cardiac ultrasound screening.

Acknowledgements: This research was supported by the Science Tokyo Support Program for Doctoral Students, funded by the Universities for International Research Excellence.