Supplementary Information

Supplementary Table S1 Position evaluation criteria

(I) Parasternal long-axis view

Position	Criteria
PLAX	Left atrium (LA), left ventricle (LV), left ventricular outflow tract (LVOT), right ventricle (RV), aortic valve (AV), mitral valve (MV), and interventricular septum (IVS) are visible.
PLAX_cc2	The left ventricular cavity becomes even smaller (almost absent).
PLAX_cc1	The left ventricular cavity appears smaller, with a false apex and visible chordae tendineae.
PLAX_cw1	The left ventricular cavity appears smaller, with a false apex and visible chordae tendineae, accompanied by a small "wine cork" appearance.
PLAX_cw2	A cross-section between the long-axis and short-axis views.
PLAX_ra2	The anterior mitral leaflet tip is located in the rightmost quarter of the field, and the aortic valve is not visible.
PLAX_ra1	The anterior mitral leaflet tip is fully visible on the right half of the field; if the aortic valve is cut off, it is considered poor.
PLAX_rt1	The mitral valve is fully visible in the left half of the field.
PLAX_rt2	The left end (tip) of the anterior leaflet touches or is cut off at the edge of the field.
PLAX_sm2	The left ventricular cavity becomes even smaller (almost absent).
PLAX_sm1	The left ventricular cavity becomes smaller, with a false apex and visible chordae tendineae.
PLAX_sl1	A small "wine cork" appearance. *
PLAX_sl2	A large "wine cork" appearance. *
PLAX_hp	The beam is not perpendicular to the LV, with the apex appearing farther from the probe and the aortic root closer. (LV is not horizontal.)
PLAX_lp	The beam is not perpendicular to the LV, with the apex appearing closer to the probe and the aortic root farther. (LV is not horizontal.)

*"wine cork" appearance refers to a state where the left ventricular outflow tract (LVOT) region exhibits trapezoidal high echogenicity, resembling the appearance of being sealed with a wine cork.

(II) Parasternal short-axis view

Position	Criteria
PSAX	LV, RV, IVS, Anterior leaflet mitral valve (AMVL), Posterior leaflet mitral valve (PMVL) are visible. The LV is as circular as possible. The left ventricular cavity is aligned with the centerline of the field and remains within the inner boundary of the field.
PSAX_cc2	The left ventricular wall appears interrupted and elongated horizontally, with the mitral valve resembling a long-axis view.
PSAX_cc1	The left ventricular wall appears continuous and elongated horizontally, with the mitral valve resembling a long-axis view.
PSAX_cw1	The left ventricular wall appears continuous and elongated vertically, with the mitral valve resembling a four-chamber view.
PSAX_cw2	The left ventricular wall appears interrupted and elongated vertically, with the mitral valve resembling a four-chamber view.
PSAX_ra2	The left ventricular cavity shifts further to the right, exceeding the inner boundary and extending outside the field.
PSAX_ra1	The left ventricular cavity shifts slightly to the right without overlapping the centerline and remains within the inner boundary of the field.
PSAX_rt1	The left ventricular cavity shifts slightly to the left without overlapping the centerline and remains within the inner boundary of the field.
PSAX_rt2	The left ventricular cavity shifts further to the left, exceeding the inner boundary and extending outside the field.
PSAX_ta2	The aortic valve is not visible.
PSAX_ta1	The aortic valve is visible.
PSAX_ta0	An intermediate view between the aortic and mitral valve levels.
PSAX_tp1	The papillary muscles are visible.
PSAX_tp2	The papillary muscles are not visible.
PSAX_hp2	The aortic valve is not visible.
PSAX_hp1	The aortic valve is visible.
PSAX_hp0	An intermediate view between the aortic and mitral valve levels.
PSAX_lp1	The papillary muscles are visible.
PSAX_lp2	The papillary muscles are not visible.

(III) Apical Four-chamber view

Position	Criteria
A4C	LA, LV, LVOT, RV, AV, MV, IVS are visible (ideal). It is acceptable if the RV lateral wall is not visible during LV imaging.
A4C_cc2	RA and RV cavities disappear.
A4C_cc1	RA and RV cavities become smaller.
A4C_cw1	LA and LV cavities become smaller.
A4C_cw2	LA and LV cavities disappear.
A4C_tp0	The five chambers (RA, RV, LA, LV, Aorta (Ao)) are visible.
A4C_tp1	LA disappears.
A4C_tp2	Both RA and LA disappear.
A4C_ra_cc	The LV lateral wall is near the right edge of the field, with RA and RV cavities disappearing.
A4C_ra	The LV lateral wall is near the right edge of the field.
A4C_ra_cw	The LV lateral wall is near the right edge of the field, with LA and LV cavities disappearing.
A4C_rt_cc	The RV lateral wall is near the left edge of the field, with RA and RV cavities disappearing.
A4C_rt	The RV lateral wall is near the edge of the field.
A4C_rt_cw	The RV lateral wall is near the left edge of the field, with LA and LV cavities disappearing.
A4C_rt_sm	The apex is cut off at the right edge of the field.
A4Chw_ra	The lengths of the IVS and IAS are equal (1:1), with the RA and RV lateral walls near the right edge of the field.
A4Chw	The lengths of the IVS and interatrial septum (IAS) are equal (1:1).
A4Chw_rt	The lengths of the IVS and IAS are equal (1:1), with the RA and RV lateral walls near the left edge of the field.

Supplementary Table S2 Quality evaluation criteria

(I) Parasternal long-axis view

Quality	Criteria
Best	LA, LV, LVOT, RV, AV, MV, and IVS are visible, and chordae tendineae are not continuously depicted.
Acceptable	The beam is not perpendicular to the LV (LV appears tilted or not horizontal). A false apex is visible. One structure is invisible during either systole or diastole. Chordae tendineae appear intermittently.
Poor	Any one of LA, LV, LVOT, RV, AV, MV, or IVS is not visible.
Bad	Two or more of LA, LV, LVOT, RV, AV, MV, or IVS are not visible.

(II) Parasternal short-axis view

Quality	Criteria
Best	LV, RV, IVS, and MV are visible, with the LV appearing circular and centrally aligned within the field.
Acceptable	LV is not perfectly circular. In diastole, the LV is circular, but in systole, it resembles a snowman shape (intermediate view between mitral and aortic valve levels).
Poor	Any one of LV, RV, IVS, AMVL, or PMVL is not visible. RV appears reduced by more than half its normal size. In diastole, the LV resembles a snowman shape, and the aortic valve is not visible.
Bad	Portions of the anterior, lateral, or inferior LV walls are cut off. Two or more of LV, RV, IVS, AMVL, or PMVL are not visible. Two or more of LA, LV, RA, RV, IVS, MV, TV, or IAS are not visible. IVS and IAS lengths are equal (1:1), with a septal tilt of approximately 20° or more.

(III) Apical Four-chamber view

Quality	Criteria
Best	LA, LV, RA, RV, IVS, MV, TV, and IAS are visible (ideal). Even if the RV lateral wall is not visible, all other structures are depicted. In diastole, the LV lateral wall is visible (RV wall may be partially missing).
Acceptable	In systole, the LV lateral wall is visible (RV wall may be partially missing). The apex is slightly truncated but the LV lateral wall remains visible (artifact). Septal tilt is approximately 20° or more.
Poor	Any one of LA, LV, RA, RV, IVS, MV, TV, or IAS is not visible. IVS and IAS lengths are equal (1:1). The LV lateral wall is not visible in systole. The aortic valve (Ao) is visible, indicating a five-chamber view.
Bad	The LV apex is not centrally located within the field (frame-out). Two or more of LA, LV, RA, RV, IVS, MV, TV, or IAS are not visible. IVS and IAS lengths are equal (1:1), with a septal tilt of approximately 20° or more.

Supplementary Table S3 Inference time, model size, and overfitting-related parameters for each backbone architecture

Backbone architecture	Inference time, mean (SD) [ms]	Parameters (M)	Model size [MB]	Validation F1 score
efficientnet_b1	15.24 (1.39)	6.52	25.82	0.99737
efficientnet_b2	17.25 (2.38)	7.71	30.55	0.99737
nfnet_f0	24.70 (6.50)	68.43	273.70	0.41839
mobilenetv2_050	9.03 (1.17)	0.69	2.69	0.99784
mobilenetv2_100	8.99 (1.07)	2.23	8.77	0.99689
mobilenetv2_110d	11.87 (1.34)	3.24	12.77	0.99761
mobilevit_xxs	15.73 (1.67)	0.95	3.79	0.99665
mobilevit_xs	17.23 (1.59)	1.93	7.70	0.99486
mobilevit_s	18.49 (1.84)	4.94	19.71	0.99784
mobilevitv2_050	23.04 (3.43)	1.11	4.43	0.99737
mobilevitv2_075	25.98 (1.78)	2.48	9.88	0.99952
mobilevitv2_100	29.97 (2.09)	4.39	17.50	0.99641

Experiments were conducted on a MacBook Pro with Apple M1 Pro GPU using PyTorch with Metal Performance Shaders (MPS) backend.
Dataset size was 1,335 KB for all experiments.

Supplementary Table S4 Distribution of positions and quality in the main training dataset

(I) Parasternal Long Axis view			Quality			
		total	**best**	**acceptable**	**poor**	**bad**
Position	**PLAX**	14,089	7,985	3,911	2,027	166
	PLAX_cc2	14,089	0	0	302	13,787
	PLAX_cc1	14,089	0	0	10,075	4,014
	PLAX_cw1	14,089	0	0	11,492	2,597
	PLAX_cw2	14,089	0	0	0	14,089
	PLAX_ra2	14,089	0	0	204	13,885
	PLAX_ra1	14,089	358	6,002	6,214	1,515
	PLAX_rt1	14,089	16	1,098	10,220	2,755
	PLAX_rt2	14,089	0	208	375	13,506
	PLAX_sm2	14,089	0	238	0	13,851
	PLAX_sm1	14,089	217	423	8,716	4,733
	PLAX_sl1	14,089	117	496	9,281	4,195
	PLAX_sl2	14,089	0	0	0	14,089
	PLAX_hp	14,089	140	7,054	5,744	1,151
	PLAX_lp	14,089	0	7,152	5,083	1,854

(Ⅱ) Parasternal Short Axis view			Quality			
		total	**best**	**acceptable**	**poor**	**bad**
Position	**PSAX**	11,690	9,210	1,452	970	58
	PSAX_cc2	11,690	0	0	645	11,045
	PSAX_cc1	11,690	0	519	7,709	3,462
	PSAX_cw1	11,690	0	306	9,347	2,037
	PSAX_cw2	11,690	0	0	0	11,690
	PSAX_ra2	11,690	0	0	0	11,690
	PSAX_ra1	11,690	318	2,388	7,579	1,405
	PSAX_rt1	11,690	319	787	8,606	1,978
	PSAX_rt2	11,690	0	0	0	11,690
	PSAX_tp2	11,690	0	221	1,306	10,163
	PSAX_tp1	11,690	8,176	1,176	1,915	423
	PSAX_ta0	11,690	0	337	10,805	548
	PSAX_ta1	11,690	0	0	2,712	8,978
	PSAX_ta2	11,690	0	0	0	11,690
	PSAX_hp2	11,690	0	0	0	11,690
	PSAX_hp1	11,690	0	0	2,433	9,257
	PSAX_hp0	11,690	0	1,114	8,356	2,220
	PSAX_lp1	11,690	6,475	1,181	3,170	864
	PSAX_lp2	11,690	0	0	990	10,700

(Ⅲ) Apical Four-chamber			Quality			
		total	**best**	**acceptable**	**Poor**	**bad**
Position	**A4C**	9,007	3,964	2,135	2,428	480
	A4C_cc2	9,007	0	0	0	9,007
	A4C_cc1	9,007	0	0	5,715	3,292
	A4C_cw1	9,007	0	0	6,003	3,004
	A4C_cw2	9,007	0	0	0	9,007
	A4C_tp0	9,007	0	0	6,478	2,529
	A4C_tp1	9,007	0	0	4,817	4,190
	A4C_tp2	9,007	0	0	0	9,007
	A4C_ra_cc	9,007	0	0	151	8,856
	A4C_ra	9,007	0	1,066	7,140	801
	A4C_ra_cw	9,007	0	0	0	9,007
	A4C_rt_cc	9,007	0	0	782	8,225
	A4C_rt	9,007	173	2,965	3,329	2,540
	A4C_rt_cw	9,007	0	0	486	8,521
	A4C_rt_sm	9,007	0	0	793	8,214
	A4Chw_ra	9,007	0	0	403	8,604
	A4Chw	9,007	0	0	5,234	3,773
	A4Chw_rt	9,007	0	0	1,260	7,747

Supplementary Figure S1 Classification results of the position evaluation model for all sections, including non-optimal sections

