PERSON IDENTIFICATION VIA EAR BIOMETRICS

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ABSTRACT

Unconventional methods of personal biometrics are gaining popularity not only in academic circles but also in the commercial sphere. This paper focuses on the human ear as an alternative biometric modality and builds on top of the current trends in ear recognition. In this paper, we present a method for generating a dataset for ear recognition, and we trained multiple deep-learning models on an existing ear recognition dataset. Furthermore, we provide a thorough evaluation and comparison of used models and training methods with current state-of-the-art research in ear recognition.

MODEL ARCHITECTURE

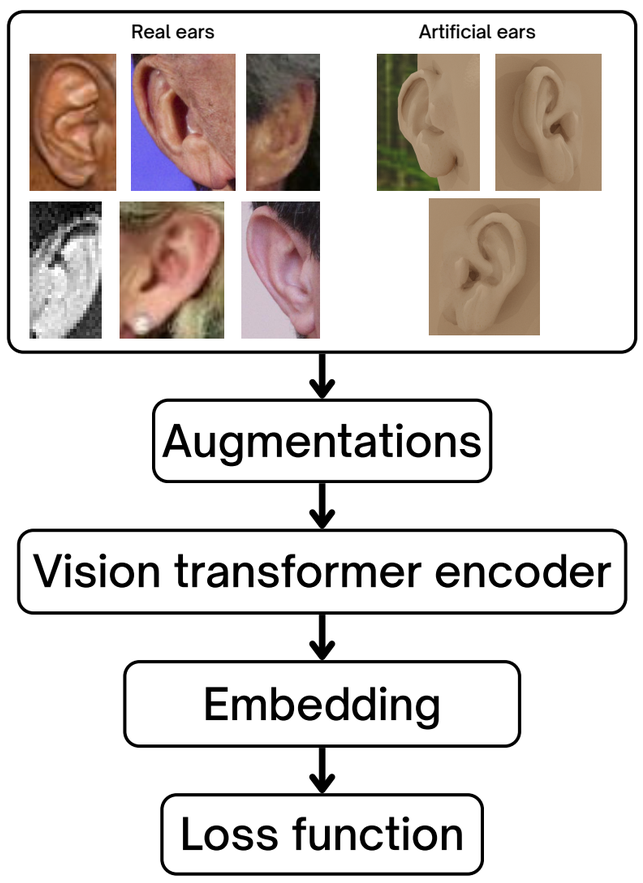
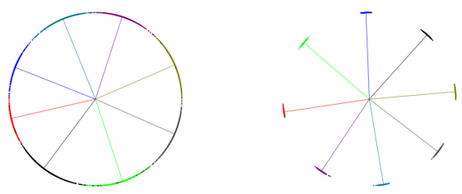


Figure 1: Training setup structure - individual training steps differ mainly in input data and loss function

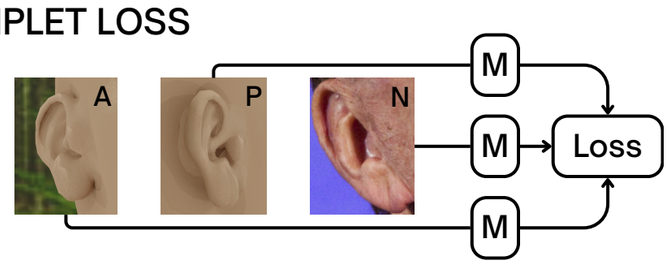
ARCFACE LOSS



(a) Norm-Softmax (b) ArcFace

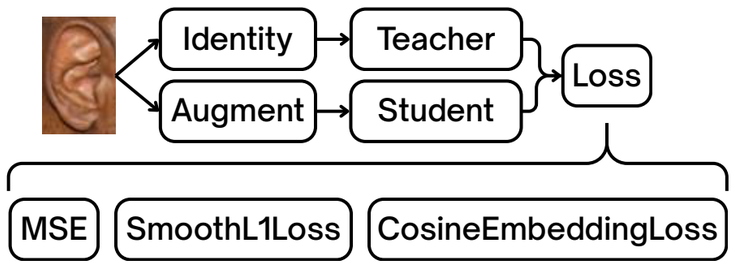
$$L_3 = -\frac{1}{N}\sum_{i=1}^{N}\log\frac{e^{s(\cos(\theta_{y_i}+m))}}{e^{s(\cos(\theta_{y_i}+m))}+\sum_{j=1,j\neq y_i}^{n}e^{s\cos\theta_j}}$$

TRIPLET LOSS



$$L(a,p,n) = \max\{d(a_i,p_i) - d(a_i,n_i) + \text{margin}, 0\}$$

SELF KNOWLEDGE DISTILLATION



ALIGNMENT (PREPROCESSING)

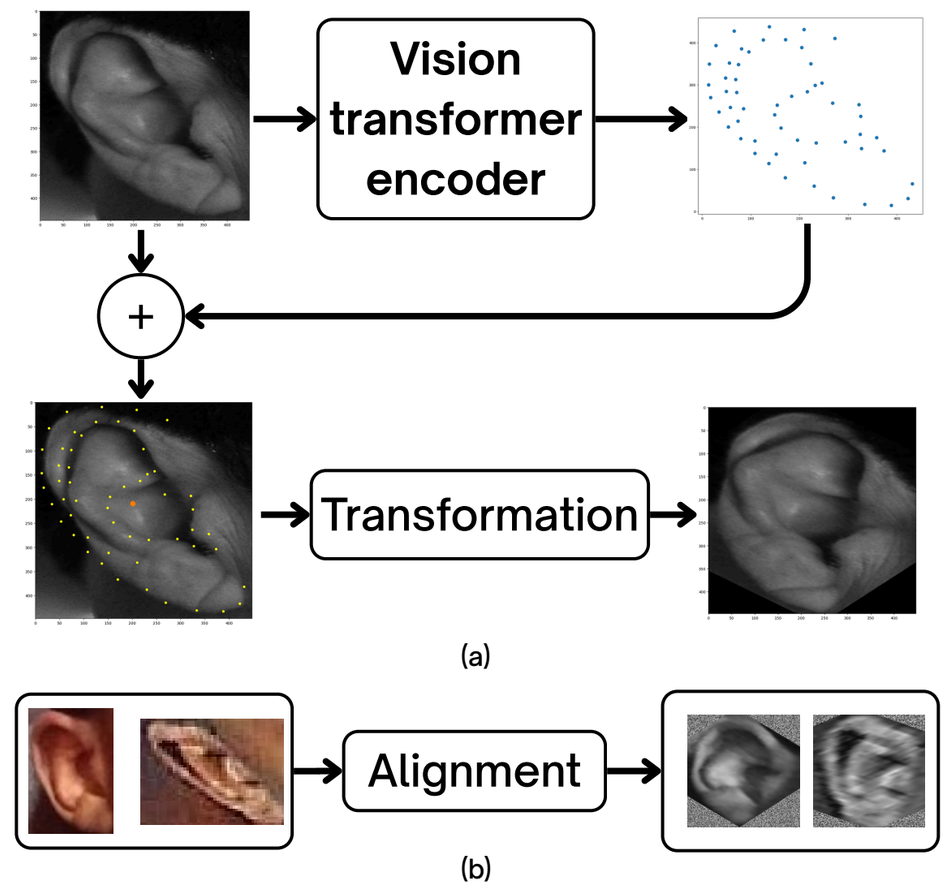


Figure 2: Key point detection and transformation pipeline (a) and example of transformation of two images during inference (b).

RESULTS

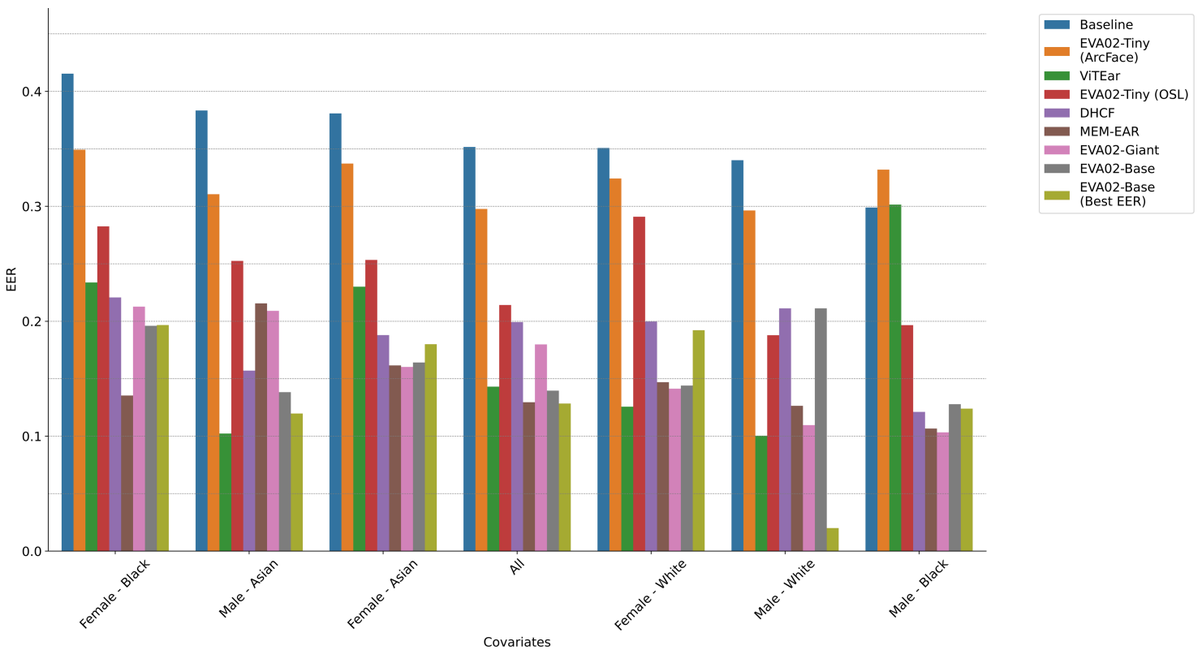


Figure 3: Comparison of differential performance due to demographics at the EER operating point with respect to different demographic subgroups. Comparing EVA02 models with the best UERC2023 models.

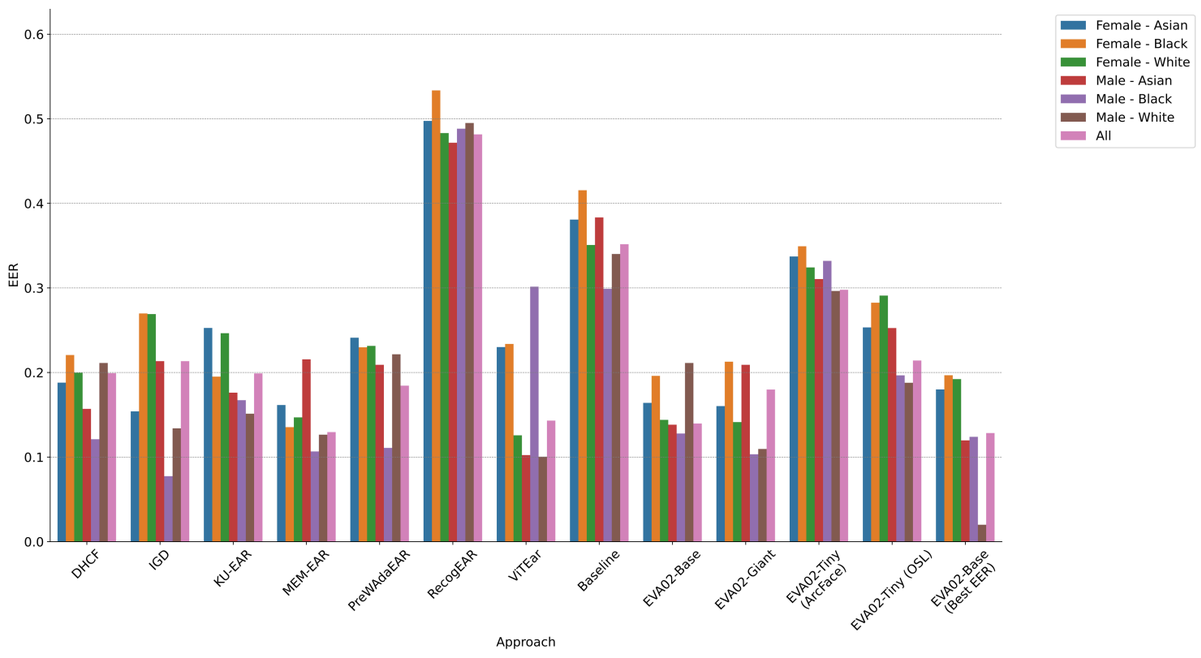


Figure 4: Comparison of the spread of performance due to demographics at the EER operating point for different models. Comparing EVA02 models with UERC2023 models.

Model	EER[%]	AUC[%]	F1F[%]	R1[%]	GINI [%]	UERC Ranking [%]
MEM-EAR	**14.60**	**91.50**	31.30	-	11.60	**14.00**
ViTEar	17.70	90.80	**27.80**	-	22.40	16.70
DHCF	18.50	89.50	35.50	-	9.20	17.90
IGD	19.00	86.80	48.30	-	19.50	18.30
KU-EAR	19.80	88.00	41.40	-	9.90	18.60
PreWAdaEAR	20.40	88.70	37.80	-	10.10	18.90
RecogEAR	49.30	49.40	99.90	-	**1.90**	39.80
UERC Baseline	36.00	69.90	90.80	-	5.30	29.90
Eva02-B-448 Arcface only	14.45	89.63	35.21	86.20	12.18	16.74
Eva-G-336 Arcface only	17.98	90.87	32.63	**91.54**	14.49	15.65
Eva02-B-448 Arcface only + artificial data	21.79	87.97	43.27	80.86	10.12	17.98
Eva02-B-448 Arcface + norm + conv	23.42	84.34	73.75	72.61	8.44	20.79
Eva02-Ti-336 Arcface only	29.77	76.12	88.59	57.98	**3.29**	26.34
Eva02-B-448 Arcface + osl (euclid) fixed batch	18.54	88.34	38.96	86.20	13.40	16.13
Eva02-B-448 Arcface + osl (euclid) 1024 batch	20.35	88.23	42.62	82.94	18.92	17.69
Eva02-B-448 Arcface + osl (euclid) 2048 batch	22.66	87.28	46.38	83.29	18.22	18.02
Eva02-B-448 Arcface + osl (cos) fixed batch	24.37	86.76	47.48	81.41	9.99	20.49
Eva02-Ti-336 Arcface + osl (euclid) 512 batch (32 samples)	26.92	79.63	83.82	34.26	8.62	25.53
Eva02-Ti-336 Arcface + osl (euclid) 512 batch (192 samples)	21.41	86.31	72.83	57.49	8.86	20.94
Eva02-B-448 Arcface + triplet	14.73	90.68	34.42	84.40	14.72	16.02
Eva02-B-448 Arcface + triplet + self learning cosine (1)	**12.84**	**91.60**	36.14	85.51	21.73	15.33
Eva02-B-448 Arcface + triplet + self MSE	13.72	90.80	31.84	85.37	17.43	18.09
Eva02-B-448 Arcface + triplet + self learning smoothL1 (beta=0.5)	13.96	90.71	**30.29**	86.13	9.95	**14.80**
Eva02-B-448 Arcface + triplet + self learning smoothL1 (beta=1)	14.45	90.79	35.86	85.37	11.73	15.20
Eva02-B-448 Arcface + triplet + self learning cosine (2)	16.27	91.06	39.31	85.37	12.86	17.61

Table 1: Comparison between different models and training methods on UERC2023 dataset

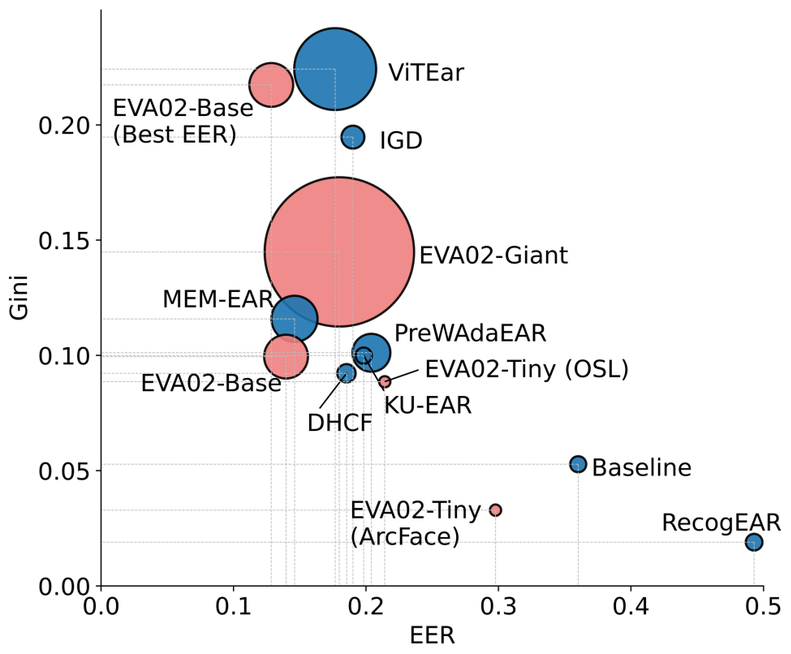


Figure 5: Comparison between best EVA02 models (red) and UERC2023 models (blue) on GINI (bias performance) and EER (verification performance). The selected EVA02-Base models are a new pareto optimal models with best GINI/EER performance.